A CENTURY OF
INDUSTRIAL PROGRESS

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WITH A FOREWORD BY
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THE AMERICAN INSTITUTE

By Edwin Forrest Murdock
President, The American Institute

SAID Henry Clay, in a speech just after the War of 1812, appealing for an American Policy, later known as the American System:

"I appeal to the friends around me, with whom I have been associated for years in public life; who nobly, manfully vindicated the national character of a war, waged by a young people, unskilled in arms, single-handed, against a veteran power—a war which the nation has emerged from covered with laurels; let us do something to ameliorate the internal condition of the country; let us show that objects of domestic no less than those of foreign policy receive our attention."

The American Society was one answer to the call to "do something to ameliorate the internal condition of the country." And the American Society became, on February 19, 1828, the American Institute of the City of New York, "incorporated for the purpose of encouraging and promoting domestic industry in this State and the United States,"—a purpose which has been instrumental in winning for our country the industrial supremacy of the world.

To appreciate the significance of these movements it is necessary to recall the position of the country before the War of 1812, and the years following. Prior to the war, the recently independent States had depended mainly on England for their finished products, and on commerce with foreign countries for their general prosperity. Due to conditions prior to and during the War of 1812, there was a sharp decline in commerce. Manufacture, heretofore unable to make much headway, now, unhampered by foreign competition, was able to develop to an almost amazing degree. This showed that,

favored by protection, America's own industry could supply her needs. Moreover, due to the patriotism developed by the war, strong feeling arose to use only American-made goods—to develop America's resources to the utmost.

It was to encourage this spirit which most interested the American Institute, and its first step in this direction was the holding of annual fairs. This phase of Institute work began with the Fair of 1828, held at Masonic Hall on Broadway and Pearl Street, on which momentous occasion the opening address was delivered by the Hon. Edward Everett of Boston. At these fairs were displayed the finest products of agriculture and manufacturing, the newest types of machinery, the most recent contributions of inventive genius, in short, everything bearing on American life. They served a twofold purpose: that of playing the part of demonstrator to the public and that of furnishing an incentive to the exhibitors, both through competition and through the desire to win the very liberal awards and premiums. Such was the means by which the Institute coaxed and urged the infant industries along the path of progress.

An inkling of the popularity and size of these fairs can be gained from some of the old records. The receipts of the Fair of 1835 showed that there were 22,000 paid admissions—quite an attendance in view of the youth of the Institute and the size of the city at that time.

While the displays of farm products and implements were in themselves highly important, special efforts were made to be of assistance in agriculture, as the basis of industry. From the very beginning, in connection with the fairs, plowing and spading matches were held. And since it was important to know as much as possible about rocks and soils, "to provide the basis of a system of husbandry adapted to all their varieties," the American Institute promptly memorialized the Legislature of New York in favor of a geological survey. The Institute was justly gratified when a law was passed the following year providing for a survey and making an appropriation for the purpose.

In 1843 the Farmers' Club was organized. Here discus-

sions, debates, and lectures were held on questions of significance to the farmer. And this section was active from the day of its birth until its worthy offspring, the New York Horticultural Society, came into the world, about the beginning of the twentieth century. As one of the friends of the Institute stated recently, "The Farmers' Club provided a meeting place for the pioneers of agriculture."

In 1842 and for some years afterward, the Institute did all in its power to procure the passage of a law which would establish an agricultural college and pattern farm for New York City. That the attempt failed does not diminish our respect and admiration for so laudable a cause.

In 1848, as the result of correspondence with the Massachusetts and Pennsylvania Horticultural societies, the American Institute offered "to provide a room and other conveniences for the accommodation of a Fruit Growers' Convention." This was the inception of the National Pomological Conventions and, we have it on good authority, of the American Pomological Society.

To digress a moment—Hendrick Van Loon in one of his works has commented rather at length, and, may one say, with something akin to envy, on the amount of work our forebears accomplished. The same thought comes to mind when one goes through the Institute records. It would seem that these mammoth fairs and the by no means trivial activities directed towards aiding agriculture would be quite enough to keep every member of an organization very well occupied. Not so the American Institute, however. In addition, it attempted to stimulate interest in other phases of the country's development.

In the very early years of the Institute's existence, the national mind reflected rather seriously as to the possibilities of introducing silk culture in the United States. The Institute promptly picked up the cue by importing seeds of the mulberry tree and distributing them "to all learned, religious, and public institutions possessed of ground in which seeds can be cultured, and to all farmers and proprietors of land." While the attempt to introduce silk culture was unsuccessful, the interest aroused gave great impetus to silk manufacturing.

At about the same time, transportation became a question of moment, and from 1819 to 1837 canals were the most emphasized means of transportation. This was due to the plan for the promotion of economic development advocated by the American System. The Erie Canal and its extensions were naturally most important for New York and for that reason the American Institute memorialized the Legislature in 1834 on the "expediency of opening a canal passage between the Allegheny River, at Olean, and the Erie Canal, at Rochester." The following year, the Institute called a convention at Utica to arouse the public to the need for this passage, and then again memorialized the Legislature. At last, in 1836, a bill was passed which authorized the building of the canal.

Not yet content with its almost superhuman accomplishments, the Institute found still another item which needed attention and thereupon proceeded to make an application for an amendment of the Patent Law so that greater protection would be given to inventors. This occurred in January of 1836, and by the time July came it appears the revision had been made in accordance with this application.

The years from 1819 to about 1836 were years of great progress in the United States. These were the years when the first harvests of the American System were being reaped. But the rapid expansion bred a spirit of speculation, which was the cause of the Panic in 1837, economists tell us. However that may be, the Institute called a convention of business men at Philadelphia in August, 1837, "for the purpose of a full and candid exchange of sentiments, and a thorough investigation of cause and effect, and concert in action, which would greatly conduce to a favorable state of things and, it is hoped, hereafter prevent the recurrence of the evil."

The next period, from 1840 to 1860, was an era of great inventions. And many of the most important of these received their first recognition at Institute Fairs. The Francis Metallic Lifeboat and the Morse magnetic telegraph, both universally known to-day, made their first bow at Castle Garden, now the Aquarium in Battery Park, in connection with the Fair of 1842. The McCormick Reaper, which practically revolution-

ized agriculture, first aroused interest through the Fair of 1848. In 1851, Singer received the Institute's highest award, a gold medal, for the best sewing machine displayed. Later, wide interest was aroused through this medium in such inventions as the Bell Telephone and the Remington Typewriter.

It was during the later years of this period that the awakening interest in science resulted in the organization of the Polytechnic Section of the Institute, its meetings being held at Cooper Union. While at first it was only a place for informal discussion on things scientific, by 1865 it developed so far as to begin regular courses of scientific lectures. For about twenty-five years this work continued to increase in scope and importance, until it became necessary to branch out into additional sections dealing with certain specialized phases of science. In the last few years of the nineteenth century, electricity as a source of motive power in industry became a highly important question, and accordingly in 1892 an Electrical Section was organized in the Institute. At about the same time, photography aroused interest which resulted in the organization in 1897 of a Photographical Section, whose offspring the New York Photographical Society is. One of the old members of the Institute, in talking of photography recently, informed us that at one of the meetings of the Polytechnic Section, some little time before the Photographical Section was formed, he had witnessed work in photography which was much like the present moving picture—then as yet entirely unknown!

Just how comprehensive the work of the various sections was may be understood when one learns that the Electrical Section and the Farmers' Club at certain periods held examinations, and that certificates were issued by the University of the State of New York. These certificates in many instances entitled the holders to practice in their respective professions.

It is interesting now to observe the men who guided the Institute during all these years. One of the very first presidents of the Institute was James Tallmadge, who took the chair in 1832. Tallmadge had a long and fruitful career in the affairs of the United States as well as in those of the Institute. At

the outset of his political life he was private secretary to Governor George Clinton. In 1818, he was chosen a member of Congress, and there distinguished himself in debates, and especially in advocating the ideals of the American System. Then in 1824, he was chosen Lieutenant Governor of New York, running on the ticket with DeWitt Clinton. In 1838, he went to Europe, where he rendered this country an important service by prevailing upon the Emperor of Russia to remove most of the regulations which had embarrassed American commerce, and also to allow the introduction of American machinery.

In his work with the Institute, he devoted great effort to the attempted introduction of silk culture. In many of his addresses before the Institute he stressed the importance of a protective tariff and the work of internal improvement. His great influence on the Institute is evident by the fact that he was its president from 1832 to 1846 and again from 1848 until his death in 1853.

Mahlon Dickerson, who steered the Institute from 1846 to 1848, was another statesman, for many years in the political limelight. In 1811 and 1812 he was elected to the New Jersey Legislature. Then he became, in turn, associate justice of the New Jersey Supreme Court, Governor of New Jersey, and United States Senator, which office he held for sixteen years. In 1833, he was again elected to the Legislature, and the following year was nominated as minister to Russia. He declined, however, and was then appointed Secretary of the Navy. Throughout his political career and his years of activity in the affairs of the Institute he had constantly upheld the policy of protection to domestic industries.

In 1853, at the death of James Tallmadge, Robert L. Pell became president. Pell was an authority on the biological sciences, and his lectures before the Farmers' Club and the Polytechnic Section were highly valuable to the Institute.

After Pell came James Renwick, in 1859. Renwick was professor of Natural Philosophy at Columbia College, and his lectures and treatises on the different sciences were known throughout the State. In addition to his own works on science,

he edited the works of many other scientists and translated many treatises of foreign writers. His correspondence with Washington Irving, his biographies of DeWitt Clinton, John Jay, Alexander Hamilton and Robert Fulton are only a few of the interesting works of his pen. His position as one of the scientific authorities of his day was immensely valuable to the Institute in connection with its work in the Polytechnic Section.

1866 saw Horace Greeley seated in the presidential chair of the Institute. To dwell on his importance in our national life is unnecessary, and his consequent influence on the Institute can be readily inferred—especially in connection with the Farmers' Club, as a result of his interest in agriculture. Characteristic of his "national" spirit was his attempt to make the Institute national, as the following bill, passed through his influence, shows:

Passed April 21, 1866.

The People of the State of New York, represented in Senate and Assembly, do enact as follows:

Section 1. William B. Astor, Cornelius Vanderbilt, Alexander T. Stewart, Denning Duer, Abiel A. Low, George Law, S. F. B. Morse, Erastus Corning, Gerritt Smith, Ezra Cornell, John Magee, Dean Richmond, Edwin D. Morgan, and Edwin A. Stevens are hereby constituted a Board of Regents of the American Institute of the City of New York, and they and their successors shall have the power to fill any vacancy in their own number.

Section 2. The Board of Trustees of the American Institute, the Mayor of the City of New York, the Governor of the State of New York, and the Secretary of the Interior of the United States Government, shall be ex-officio members of the said Board of Regents.

Section 4. The said Board of Regents shall have power to purchase or receive . . . real and personal estate . . . and to sell or dispose of the same, as they may think proper, in the erection of buildings, the construction of laboratories, machinery, and museums of art, for the use of the said Institute; and

they may appropriate a portion of the annual income to establish and maintain professorships and lectures in the said city of New York on Natural History, Physics, Chemistry, and their application to the useful arts; and also to print and circulate throughout the United States documents relating to Agriculture, Manufactures and Commerce; and to use any other means to make the said Institute *national* in its influence and character.

This act culminated, in 1871, in a plan "to build a structure, or group of structures, for a vast permanent Universal Exhibition and Rendezvous of specimens of all the products, Manufactures, Trades, Machinery, both land and sea, of the New World—and for Science and Art." The chief features of this permanent Exhibition were to be:

An exhibition of the finest examples of American workmanship and ingenuity, grouped geographically.

A department of contrasts, "wherein may be seen the obsolete mechanisms of a century ago in juxtaposition with the marvelous machinery of to-day (1871), together with such as would indicate the intermediate steps."

Museums of American minerals and American Geology.

A Museum devoted to the fine arts which would include a permanent gallery of American Paintings, a great hall of American Statuary, and a vast Musical Conservatory.

A department "consecrated to Learning." This was to include a Lecture Hall for lectures and discussions on the sciences, a great scientific Library and a Chemical Laboratory and workshops.

This breath-taking plan furnished the inspiration for Walt Whitman's poem, "After all, Not to Create Only," which he read to formally inaugurate the opening of the Fair in 1871.

But work had only just begun towards the execution of this plan when the terrible Panic of 1873 occurred, dragging in its ruinous wake the awe-inspiring dream of the Institute's "great industrial palace."

Coincidentally with the move to enlarge the work of the Institute and to make it national in scope, William B. Ogden followed Greeley to the presidency. Ogden's name is better

known in the Middle West than it is in New York, due to his having spent the greater part of his life in Chicago. While he was still a young man he became active in that city, originating most of the public improvements of the time. He was the first mayor of Chicago and president of a great many of its enterprises, among which were the Chicago branch of the Illinois State Bank, and Rush Medical College. His business interests, however, brought him to New York so often that in 1866 he bought a home in Westchester County, where he spent the remaining years of his life.

In 1872, Frederic A. P. Barnard assumed the leadership of the Institute. While the name is not an unfamiliar one, few people, outside of those in the field of education, actually know what it signifies. Barnard went from the position of teacher in the Deaf and Dumb Institution at Hartford to the University of Alabama, then to the University of Mississippi, of which he became president in 1856, and finally, in 1864, to the presidency of Columbia. Here he did much not only for Columbia but for American education as a whole. His was the first proposal for a uniform system of entrance examinations for all colleges of New York. His reports influenced subjects such as the study of modern languages, the elective system, co-education, fellowships as a means of starting graduate schools. (Johns Hopkins formally adopted his ideas on this subject in 1876.) In some of his reports he mentioned the need of a Law School and a Medical School, thus initiating the idea of a University for Columbia. Barnard College, Teachers College, and the School of Mines are living monuments to him.

Many other men, prominent in their respective day, were active in promoting the work of the Institute. Some of them are: Dr. Felix Pascalis, an authority on silk culture, who aided the Institute in its experiments in this direction; Erastus Fairbanks, the maker of the scales; John J. Mapes, an authority on agriculture, whose lectures before the Farmers' Club were exceedingly valuable; Peter Cooper, the founder of Cooper Union; R. M. Hoe, inventor of the Hoe printing press; Isaac DeVoe, maker of the DeVoe paints; Orestes Cleveland, mem-

ber of the New Jersey Legislature for a few years; Charles F. Chickering, manufacturer of the Chickering piano; Joseph Francis, the inventor of the lifeboat; Whitelaw Reid, editor of the *Tribune* after Horace Greeley and Special Ambassador to England upon several occasions; Richard Esterbrook, Jr., manufacturer of the Esterbrook steel pen; Oscar G. Mason, who made some important advances in photography and was the first to use the X-ray photograph.

The first Honorary Members of the Institute were Henry Clay and Daniel Webster. Henry Clay's letter in this connection follows:

June 3, 1831.

GENTLEMEN:

I have received your favor of the 18th communicating my unanimous election as an honorary member of the American Institute of the City of New York. Such an unsolicited association of my name with an Institute having in view an object so patriotic as that of the American System is inexpressibly gratifying to me, and I pray you to communicate my grateful and respectful acknowledgement to the Society, collectively and individually.

At the same time be pleased to accept for yourselves, gentlemen, assurances of the high regard of

Your obedient servant,

(Signed) H. CLAY.

By the beginning of the twentieth century, most of the Institute's work was centered on the fairs, which were still being held year in and year out. The various sections, although still active, directed their efforts more and more towards work in conjunction with the fairs. At one period, however, there was a digression, when in 1914 the American Institute financed the Extramural Division of New York University. This laudable work established a division which now has an enrollment of approximately 3,000 students, all young men employed in and about the Wall Street district.

In 1898 a Photographical Exhibition was held at the National Academy of Design. It was thought that there had been brought together for this event the largest number of profes-

sional and amateur prints ever exhibited in the United States, exhibits being received from nearly every state from Maine to California. In 1899 another Photographical Exhibition was held, this time at the Gallery of the Institute in West Forty-fourth Street.

For a period of several years after this, Horticultural Exhibits were given. Then in 1923, an Inventors' Exhibit was held. In 1926, in conjunction with the Fair, the Fellowship of the American Institute was organized. The Fellowship was awarded to those concerns which had received an award of merit fifty or more years ago and were still existent. The surprisingly long list of some two hundred and fifty prominent concerns is a testimonial to the Institute's ability to "pick the winners."

While all thought had been focalized mainly on the fairs during these recent years, it cannot truthfully be said that the fairs were still successful. Nor can it be said that this was due to lack of effort on the part of the Institute. A brief glimpse at the industrial development of the country will readily bring to light the cause. Great inventions and skillful engineering had immensely facilitated output, culminating in our present "mass production." For a time, industry was in the main vigorously competitive. Excessive competition caused a sharp reduction of business profits which in turn resulted in a movement towards industrial combination, the years between 1894 and 1903 witnessing startling mergers. Attendant on increased production and the strengthening of the competing units came the specialized business show which has made the general fair impractical and ineffectual.

It was a realization of this fact which caused the attempt, in 1925, to further stimulate invention by means of an Exposition of Inventions. But here again certain developments in industry proved this form of assistance ineffectual. It demonstrated that the laboratory had become the all-important nursery of industrial advances; that serious invention had become the concern of industry.

Conscious of its purpose and its heritage, the American In-

stitute caused a survey to be made of the industrial situation to find where and how it might best focus its energies. What it learned, in summary, may well be quoted:

"The results of the research laboratory are becoming more and more important in our lives. Not alone does it give us products which add immeasurably to comfort and luxury . . . it increases our control over life itself. And it must eventually show us how to conform and adjust ourselves to new conditions produced by it.

"It is obvious that these results of the research laboratory must be periodically brought to the attention of the public. For the public is at once the stock and bond owner and the consumer; the voter and the taxpayer. That research may be carried on and on, that money and brains and energies may be available to it increasingly, this public must be informed—and reinformed, sold and re-sold.

"It would seem to be the work of the Institute to introduce these results of the research laboratory to the public, thus continuing the work which has always been its 'raison d'être' from inception. Certainly it is a job to be done, and where is there to be found an organization better fitted than the American Institute!"

Thus we leave the American Institute of the City of New York on the turn of its first century. May it go on through the years with success to itself and profit to industry and mankind. May it ever apply to its own problems its slogan, "Eternal research is the price of survival."

EDITOR'S NOTE

IT is said that the great American novel—the gleaming goal toward which our *literati* have striven through successive generations—is yet to be written.

The Editor-in-Chief of this volume submits to a discriminating reading public that between these covers is the epic of American life and times. Here is Romance. Here is Truth stranger than Fiction. Here are Homers in recital of Odysseys as gripping in imaginativeness as any tales of mythology.

The story they have set down, dealing with the industrial progress of the Republic from the days it staggered into its appointed path to this hour of mighty stride, loses nothing of romance because couched in terms of reality. It is essentially authoritative.

Without exception, the key factors in the material development of the United States are traced and reviewed by men preeminently qualified to write such history. There is visible in every chapter a pride of achievement, which, when all is said and done, is the mainspring of America's economic glory. Many of the authors happen to be men who have amassed fortunes in the fields which claim their devotion. But one risks the conviction that they esteem their dollars as symbols of success rather than emblems of mere wealth.

The genesis of this work may not be without interest. The American Institute of the City of New York, whose record of Trojan service appears elsewhere herein, at first planned to commemorate its Centenary by having an encyclopedic analysis of American industrial progress prepared by a single author. The undersigned was honored by an invitation to be that writer.

Professional absorption in the printed and in the broadcast word, to say nothing of my lack of special equipment, deterred me from essaying so responsible a task. But I hit upon an idea which struck me, and happily appealed to the American Institute, as a far more effective method of doing

justice to the hundred fabulous years which transformed America from a wilderness into a World Power of electricity, steel and gold.

That idea was to persuade captains of American industry, commerce, science, and finance to write a book of which indubitable authenticity would be the hallmark. From my gracious collaborators have come forth data so splendidly decked out that I venture the prediction few into whose hands the volume comes will lay it down without the consciousness of having been initiated into an inspiring new story of our country's life.

To the thirty-two men whose names illumine "A Century of Industrial Progress" I offer very deep gratitude. In the days to come, I shall like to think they were inveigled into producing a masterpiece destined to fill an honored place among the other annals of American history.

To some collaborators unmentioned in the Table of Contents my thanks are due, too—in particular, to L. W. Hutchins, the energetic executive officer of the American Institute, who was indefatigable in coöperation and proved himself what once was aptly termed a master of the tedious art of taking pains.

A tower of strength, in hours of pressing need here in this community of Rumor, Recrimination and Remorse called Washington, was my first mentor in journalism—Malcolm McDowell, one of the finest political writers America has ever known and at the zenith of his career when I was a cub reporter on the *Chicago Record,* lo! these many years ago.

There is yet another to whom I would here give thanks—my young secretary, Lorraine Noetzel. The endless manual labor that made it possible for me eventually to write *Finis* could not conceivably have been accomplished so expeditiously except for her flying fingers.

Frederic William Wile

3313 Sixteenth Street, N.W.,
Washington, D. C.
January 15, 1928.

THE FORCES OF OUR ECONOMIC PROGRESS

By Herbert Hoover
Secretary of Commerce

IT would require a volume to supply even an adequate foreword to an account of the economic development of the United States in the last century, to say nothing of a few hundred words.

In 1828, when the American Institute was founded, our country was just in the beginnings of its industrial transition. Domestic and neighborhood methods of production which had predominated in a major agricultural community were leaving the household and shop to be concentrated and organized into the factory. We were still engaged in the struggle to provide transportation by turnpike and canal. The railway had just been born. Industrial life as we know it to-day was just commencing. The young republic was responding to the urge of its statesmen to work toward industrial independence.

To-day the vast totals of production and consumption as set forth in the columns of daily statistics indicate for each group, whether it be common labor, professional men, farmers, artisans and others, the highest standard of living and the greatest degree of material comfort for each of them in any country at any time in the history of the entire world. Not all of these groups have marched parallel with each other. For instance, agriculture has fallen behind the march of industry in latter years. Not all of them as yet have attained the standards which we wish, and which can be brought about. But at least in contrast with the past and with other peoples, our national circumstance is certainly a matter for thankfulness and gratitude to that Providence which has guided our country.

If we search underneath for the dominant motivation which has brought about these blessings, we shall find many powerful influences. The racial equipment of men and women who settled and founded our country; the social ideas which they brought with them and which have dominated our nation since that day; the government which they set up; the wealth of national resources, the scientific discoveries of the century and others of lesser degree—all these have been the pushing forces to progress.

The people who founded this country were a selected group with high ideals, for most of them came in protest against parts of the European system, seeking religious freedom, greater political liberty, escape from the blight of class, the demand for equality of opportunity. They were those of the large initiative and greater courage. They were people of independence of thought and action. They were a unique selection of a new people for a new country.

This courage and this dependence upon individual initiative were further developed and strengthened by the ceaseless contest with the wilderness in an ever extending frontier, yet this very struggle bred within the race a capacity for coöperation in action and emergency. America, therefore, started with changed social direction, which diverged even further from Europe as it progressed amid its new environment. The inherent instincts of individual initiative and for coöperation and organization grew without this new setting. Thus we finally developed a political and a social system widely apart not only from our mother races, but new in the whole annals of the world. I have felt that the outstanding differentiation in American social ideas from other democracies is the larger demand with us that we shall maintain an equality of opportunity to the individual, that he may rise freely in the world to whatever degree his character, ability and ambition entitle him. In this ideal lie the stimulus to initiative, the consistent rejection of class, of domination of all sorts, big and little. From it arose our pioneering of the whole idea of equal and free education, the growth of religious tolerance, and finally its expression in economic life of our demand that there shall

be no combination in restraint of trade or discriminations in dealing, which paralyze equal opportunity, and our repugnance to government in business, for there can be no opening of the door of opportunity which is closed by bureaucracy.

Our form of government has contributed to the development of these ideals and ideas not alone in its broad foundations of liberty and freedom, but its de-centralized character has given us forty-eight laboratories, through which we gain opportunity for experiment in political, social and economic progress without jeopardy to the whole.

No one needs to attempt to catalogue here our natural resources, our vast areas of rich agricultural land, our great stores of fuel, iron and other minerals, our national waterways, our water power. Nor do I need to recite here the utilization we have made of this virgin wealth.

This utilization has been the result in great degree of the progress of scientific research, discovery and invention—itself a product of individual initiative and the development of widespread education and training. When we imported the factory, science became busier and busier with discovery and invention. With resultant inventions we took hold of all the tools they gave us—steam, gas, electricity—and applied them to our national resources. Our standards of living and comfort have risen with our joyous application of every discovery.

We cannot deny that friction has grown up in this rush of development—conflicts between capital and labor, conflicts between groups of capital, invasions of the right to equal opportunity. But I believe we are in these latter years witnessing a silent revolution in many of these phases. The industrial system is fitting itself better into the social instincts of our people. There is a wider recognition of the practical processes of assuring equal opportunity to men. There is more recognition, and a steady growth, of the economic and social advantage of coöperation in all directions. We need no better proof than the extraordinary increase in the number of associations and societies bent upon common purposes. Further proof lies in the constant lessening of conflict with these ideas. I believe there is a continuing, widening acknowledgment that it is

through the rigid preservation of private initiative that we have come thus far, and a correspondingly lessening demand for government operation of business as the cure of all ills.

The result of all these fundamental currents has been the upbuilding of an enormous system of production and distribution which is constantly improving through the advance of technical understanding and increasing skill, supported by yearly perfection of public education, incessant scientific research and invention, and freedom from all but the minimum of interference with individual activities.

To recite its results in decreased sweat, increased living standards, larger development of leisure, wider diversity of life, would all involve vast statistical discussion unnecessary here, for it may be found at any moment in government publications.

Our economic system is not perfect, but whatever our national weaknesses may be, they do not lie in a lack of vitality or courage. If we can maintain the moral fiber of our people and their individual initiative, if we can maintain equality of opportunity for our youth, if we maintain the strength of our government, we shall make even greater progress in the next century.

The chapters in this volume, from the hands of many experienced men whose leadership in their fields is without question, give more than an accounting of initiative, skill and courage. They display the abilities of the men who are responsible for our industrial progress to-day.

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A HUNDRED YEARS OF AGRICULTURE

By Arthur Capper
United States Senator from Kansas

IN the early part of the nineteenth century some English farmers with plenty of capital took up land in Illinois and planned to farm there on a large scale. Their plan was frustrated by a shortage of labor. Importation of laborers from England solved the problem only temporarily. It was so easy for the newcomers to acquire land that they quickly did so and began farming for themselves. Their would-be employers regretfully decided that, in the United States, it was necessary either to farm in a small way or to spread a small amount of labor over a large amount of land.

They divined the specific problem of American agriculture. The history of farming in this country in the last century is largely a story of efforts to economize labor rather than land, whereas in Europe the opposite has been the case. In the first few decades of the nineteenth century, an American farm hand could become an independent farmer by saving his wages for a couple of years or so. With the money thus accumulated he could buy land and livestock, and could begin to equip a farm.

In such circumstances the farming of large estates by free labor was impossible. The United States accordingly became a country of independent land-owning farmers. Scarcity of labor stimulated farm mechanization, and promoted extensive rather than intensive farming. It made the American farmer more efficient than the farmer of any other country in production per unit of labor employed, although not in production per acre. It promoted methods calculated to spread a given

amount of labor over more land, and on the other hand caused methods of conserving fertility to be neglected.

Nothing has been more significant in American agricultural history than the paramount necessity of conserving labor. This necessity accounts for the prevalence of the family-size farm in the United States, for the country's preëminence in farm mechanization, and for the relatively high specialization of American farming. At the height of the westward pioneer movement in the middle of the last century farm labor was so scarce that some farmers of the older-settled regions sought to introduce indentured labor. When the open frontier disappeared, its influence on the agricultural labor supply was partly replaced by developing industry. Farmers even to-day find it burdensome to pay the competitive wage-rates established for farm labor through the influence of urban expansion. It has never been possible in the United States, except perhaps in the South during the period of slavery, to rely mainly on cheap labor as a source of profit in farming. Success in agriculture has perforce rested on the efficiency, in production and in business, of the individual farmer.

In sketching the progress of American agriculture during the last century, the decisive rôle played by the relatively greater scarcity of labor than of land will be constantly apparent. Throughout the nineteenth century a vast body of virgin land undeveloped and largely unoccupied was available for settlement. As late as 1860 more than one billion acres remained in the public domain for future disposition. Most of this land lay west of the Mississippi River. Rapid disposal of it was started under the Homestead Act of 1862, and much cheap land was thrown on the market at the same time by the States and by corporations that had received large land grants. Nevertheless it was not until the close of the century that the available free and cheap land of good quality had been taken up.

More than 600,000,000 acres of potential crop land remains to-day in private ownership, much of it fertile and requiring only clearing. It will probably be decades before our population presses seriously on our land resources. From the beginning of our history to the present time, the existence of free

or cheap land in the United States has depleted the potential labor supply of the established farmer, and steadily increased the number of his competitors. From 1860 to 1900 our farm area was doubled by the settlement of 431,370,236 acres more. It is true that in the same period the population of the country doubled also. But growing cities claimed an enlarging share of the increase, and continually emphasized the necessity in agriculture of making a little labor go a long way.

First in importance among the facts of American agricultural progress in the last century, then, was the occupation of a continent of free or very cheap land under conditions that made capitalistic farming practically impossible. In the nineteenth century our population increased fifteenfold, or from 5,000,000 to 76,000,000. An additional 28,716,045 persons were added from 1900 to 1920. Now and then the new blood flowed in faster than it could be absorbed, congestion arose in the cities, and labor was available for farmers at temporarily reduced wages. This condition, however, was always of brief duration. Labor was constantly drained away from the comparatively densely populated Eastern States into the undeveloped West, where it soon became established in farming on a basis of land ownership.

Obstacles to the westward movement of agriculture were easily overcome. Indian occupation gave way before steadily exerted force or persuasion, and pioneer farmers swarmed into the inviting region west of the Mississippi. Western lands acquired by the Federal Government from the States were sold at low prices and on easy terms. After the passage of the Homestead Act, the tide of population flowed westward more strongly than ever, particularly when it was discovered that the prairies could be more easily conquered than the forests. This looks obvious to-day. But the prairies seemed inhospitable to the first settlers. Lacking transportation facilities, fuel, wood for buildings and fences, and sometimes lacking water also, lands that are now among our richest farming regions presented a forbidding aspect. The first settlers who demonstrated the fertility of the prairies and the facility with which they could be cultivated were bold experimenters.

It was not until about 1840, when most of the available land in the timbered region east of the Mississippi had been taken up, that the pioneer movement entered the prairies. In those days people talked about "the barrens" of Iowa. But the reaper was coming into use, and a steel plow that would scour in prairie soils. Then came railroad development in the Northwest, the discovery of gold in California, the inclusion of Texas in the Union—all of which helped to stimulate western agriculture. The result was that by 1850 the States and territories of Ohio, Indiana, Illinois, Michigan, Missouri, Wisconsin, and Iowa had a population of 5,400,000, or 50 per cent. more than in 1840.

Access to new markets, through the building of railroads, gave an immense impetus to production for sale. In 1840 the country had only about 2,000 miles of railroad, three-fourths of it north of Virginia and east of Ohio. Ten years later the railroads covered 7,000 miles, including 800 miles in the Northwest States. In 1851, says a contemporary writer, more than 2,100 miles of railroad were built, and by 1862 two-thirds of the freight moved to and from the West went by railroad. About 30,000 miles of railroad were then in operation. The California migration gave a market to farmers in the upper Mississippi region, and the Eastern States took increased quantities of western wheat, corn, pork, and beef. Self-sufficing agriculture gave place to commercial agriculture. Throughout this development the availability of cheap new land kept farm labor scarce and relatively dear, both in the East and West, particularly at harvest time. Much prairie grain was lost each year for lack of harvest labor.

In colonial times American farm production was largely for consumption on the farm or in near-by settlements, rather than for sale in foreign markets. Tobacco was profitably sold in Europe and in the West Indies, and a little wheat was produced for export. Early settlers in New York and Pennsylvania developed commercial wheat production. Rice became an important commercial crop in South Carolina. Long staple sea-island cotton was introduced into Georgia in 1786. Commercial production of short-staple cotton, however, was delayed by

lack of effective means for separating the lint from the seed, and did not increase materially until after the invention of the saw gin by Eli Whitney in 1793. The problem of getting rid of surplus production in foreign markets was therefore not pressing before the westward pioneer movement developed.

Then, however, it became urgent. In 1836, owing to a partial failure of the wheat crop in the Eastern States, the United States had not enough wheat for its own needs, and had to import a considerable quantity from Europe. This necessity, however, caused the price of wheat to advance, and its production was stimulated. As a result the country got its first experience with the surplus problem on a large scale. In 1839 a large surplus of wheat was on hand, with little prospect of finding a satisfactory market. Much of it was disposed of in the Southern and Eastern States at ruinously low prices. For several years thereafter wheat remained so low in price that many farmers in the East were forced to grow other crops. It was not until after the repeal of the Corn Laws in Great Britain in 1846 that a dependable European market existed for American breadstuffs.

That event, however, was of revolutionary significance. Nothing like the expansion that took place in American agriculture following the repeal of the British Corn Laws had ever been seen before. Great Britain, through industrial expansion, soon became heavily dependent on foreign foodstuffs. Food requirements increased more rapidly than food production in certain other European countries also. The result was a steadily growing demand for American grain and meat. This expanding market removed all restraints on our production, and we became the largest agricultural surplus producing country in the world. Our production soon far exceeded our domestic requirements.

From an average of about 21,000,000 bushels a year in the sixties our wheat exports rose to an average of 189,000,000 bushels a year in the nineties. In the same period our annual exports of packing house products increased by almost 2,000,000,000 pounds, and our cotton exports nearly trebled. Crop production per capita of the population increased about 40 per

cent. It is a curious fact that in this period South America, Canada and Australia, as well as Europe, were importers of American agricultural products. When the Crimean War shut Russian wheat out of the markets of western Europe, wheat prices advanced and gave an additional stimulus to American agricultural expansion, and our wheat production in 1859 was nearly twice that of 1849.

Corn as well as wheat moved westward with the pioneers. This crop was grown by the Indians before the discovery of America by Europeans. It became important almost at once to the settlers of Virginia and Massachusetts, and crossed the eastern half of the continent with the first westward migration. By 1879 the Corn Belt as we know it had taken form, and was specializing in corn production, cattle-feeding, and hog raising. In recent years corn acreage has increased northwest of a line drawn from central Oklahoma diagonally across Missouri and Illinois to Lake Michigan, and decreased south and east of this line. Except for this change, however, the corn map is much the same to-day as it was at the beginning of the century. Corn transformed into pork and beef played a part only second to that of breadstuffs in our agricultural export trade during the last quarter of the nineteenth century, by which time the Corn Belt had become the center of the country's hog industry and the feeding place for an immense number of range cattle. The United States, in short, became not only the breadbasket but the larder of Europe. It largely supplied the food wants of Europe's growing industrial population, and by a liberal immigration policy invited coöperation in further agricultural conquests.

Europe's free market for foodstuffs, however, would have been of small value to American agriculture had it not coincided with technical progress which facilitated increased production without increased labor. With the wooden plow, the sickle, and the flail, a man had to put in a full week's work to produce twenty bushels of wheat on an acre of land. These were the implements in use in the early part of the twentieth century. Cast iron plows were used to some extent by 1825, and a threshing machine had been invented. It was not until

1833, however, that Obed Hussey patented a reaper. McCormick patented his reaper in the following year. These implements probably have accomplished more than any other agricultural inventions.

Yet as late as 1840 grain was still reaped with the cradle, and beaten out with the flail or trodden out by horses and cattle. Seed drills were practically unknown. Hay was cut with the scythe, although the mowing machine had been invented. Corn was planted by hand. These methods remained the rule until after the Civil War. In the late sixties, however, the farmers en masse adopted the inventions they had formerly neglected or despised, and a technical revolution was under way.

Threshing machinery came into use in all the important grain-growing regions, generally with separator attachments. Reapers were numerous in the Northwest, and the steel plow had largely supplanted the cast iron plow throughout the prairie region. A steam plow was tried, but was not a success. Seed drills were seen on a few farms as early as 1845. They were in general use by 1860. About the same time machines were invented for planting and cultivating corn. Less progress in mechanical methods was made in cotton growing than in grain growing, and the size of the average cotton farm was limited until quite recently by the amount of cotton the farm family could pick by hand. Nevertheless considerable labor was saved by the invention of the cotton-seed planter, the fertilizer distributor, the cotton-stalk cutter, and various kinds of plows and harrows. Power planting and cultivation of cotton developed after the World War, and harvesting by the sled or stripper was introduced in Texas and Oklahoma. By this method one man can gather as much cotton in a day as eight or ten men can pick by hand.

In the technical revolution of the sixties, which increased farm productivity per man as nothing previously had ever done, the most significant inventions were the reaper and the mower. These machines, by enormously increasing the acreage a man could harvest, enabled western farmers to take full advantage of the opportunity given them by the growth of industrial populations in Europe. Labor requirements in farming

were cut down from 30 to 50 per cent., and American agriculture, from the standpoint of production per man, became the most efficient in the world. Data comparing American with European farm productivity are not available for the period during which the seeder, the mower, and the reaper were coming into use. But an idea of what took place can perhaps be gained from a glance at the comparative situation that existed immediately before the World War. In that period the yield per person directly employed in agriculture was 159 per cent. greater for the United States than for the United Kingdom, Germany, Belgium and France.

In the half century from 1875 to 1925 the number of persons engaged in American agriculture increased about 75 per cent. Our agricultural production in the same period increased 128 per cent. This is a fair measure of agricultural progress, because it suggests the extent to which consumption goods increased in proportion to effort expended. Our viewpoint here, to be sure, is a social rather than an individual one. It would not be true to say that the average operating farmer is rewarded better to-day than his forbear of fifty years ago by the degree to which labor efficiency in farming has increased. Benefits accruing from technical progress are shared with the implement manufacturer, the railroad, the distributor, the banker, the processor of farm products, and the consumer. They are distributed throughout the social body. Gains in individual production are nevertheless as good a criterion of farm progress as we possess. By this criterion the last century established records never before approached. European countries surpassed us in increasing yields per acre, but only by an expenditure of labor proportionately much greater than the gain in yields.

Thus our apparent handicap of a labor shortage became an influence for agricultural improvement. Against the twofold attraction of an open frontier and increasing industrial opportunity, farmers found it impossible to maintain a labor-supply sufficient to carry on farming by hand methods. They were consequently compelled to rely more and more on machinery. But this necessity, far from proving a burden, was precisely

what the situation required. Increased use of labor-saving machinery enabled the United States, with a comparatively sparse population, to specialize in agriculture while western Europe specialized in manufacturing. Thus arose an extraordinary degree of economic interdependence between the two continents, which facilitated progress in both.

American agriculture in the nineteenth century grew up in a reciprocal relation with the industry of Europe. The United States exported food products, and received manufactured goods in return. Thus home requirements were supplied pending the development of domestic industry, and a market was obtained for an ever-swelling volume of farm production. It was in agriculture that the special character of American economic life, its high utilization of labor-saving machinery, first appeared. On this foundation was reared up an edifice of national prosperity in which all groups in the community found a place, not without some jostling and quarreling and some complaint about unequal distribution of advantages, but with a greater measure of well-diffused comfort and well-being than had ever previously been known in the history of the world.

Farm efficiency in the United States, as measured by production per man, advanced in ups and downs, rather than by an unbroken movement in the last third of the period we are reviewing. Output per man jumped prodigiously with the advent of improved seeding and harvesting machinery. Thereafter the gain, although continuous, took place at a declining rate until about 1919, when a new stimulus was given to it by improvements in power machinery, and by an increase in the use of large power units. Our production of field crops in the period 1922-26 was nearly 5 per cent. greater, and our output of animal products 15 per cent. greater, than in the period 1917-21. Yet from 1919 to 1924 crop land in the United States decreased 13,000,000 acres, and the period from 1920 to 1926 saw a decline in farm population of about 3,000,000. On less land and with less labor the American farmer was at his old job of enlarging the volume of production, at some risk to stability of his market, but with some little compensation in reduced costs of production. It is estimated by Dr.

O. E. Baker, of the United States Department of Agriculture, that the productivity of the average American farm worker in the period 1922-26 was at least 15 per cent. greater than in the period 1917-21. Meanwhile slight progress was made in the adjustment of production to demand, and in the control of his marketing processes.

Although the main emphasis of the century was on extensive rather than intensive farming, and high production per man was considered of more importance than high production per acre, methods of cultivation were nevertheless materially improved. Increased yields per acre in the older regions east of the Mississippi disproved the idea that farms there were worn out. In the forty years from 1885 to 1925 corn yields in Virginia and North Carolina increased ten and twelve bushels per acre respectively. Yields of corn in Maryland increased fourteen bushels, and in New England ten bushels. Iowa and Minnesota increased their corn yields eight and six bushels per acre in the same period. Wheat yields increased five to six bushels per acre in the northeastern portion of the United States.

In some of the wheat States the persistence of pioneer methods, and the expansion of wheat growing into drier areas, prevented a rise in average State yields. Nevertheless, for the country as a whole yields of wheat per acre in this forty-year period increased 17 per cent., yields of corn increased 18 per cent., yields of oats 14 per cent., and yields of potatoes 39 per cent. Total production of these crops increased 77 per cent., while the area devoted to their production increased only 52 per cent. This improvement was effected through crop rotations, increased applications of manure and commercial fertilizer, improved varieties of crops, greater production of legumes, and better preparation of the soil. Increased yields per acre were produced wherever pioneer methods disappeared.

Detailed statistics would be out of place here. Nevertheless a few figures may perhaps be allowed, to show how agricultural production increased following the technical revolution of the Civil War period. This increase of course was not due entirely to mechanical progress. Expansion of acreage and better cultivation of lands previously in cultivation played a great part in

the result. It was mechanical progress, however, that solved the labor problem and made the westward movement feasible and profitable. Improved machinery was first among the causes of the unparalleled gain in farm production.

In the output of cereals the influence of improved machinery was supplemented by the growth of transportation, and by improved methods of marketing, as well as by rapid settlement of new land. But these contributing influences were obviously dependent on a prior solution of production problems. Railroad building in the prairies would not have been economically sound had wheat growers not first learned the technique of large production; and our complex machinery for storing and marketing grain could never have come into existence without a big volume of grain to handle. Causes and effects are often interchangeable, but if priority can be assigned anywhere it can be assigned to increasing farm efficiency in tracing the main sources of American economic expansion after the Civil War.

Our production of wheat from 1860 to 1914 increased more than fivefold. In the same period our production of corn increased threefold, of barley elevenfold, of oats sixfold, and of rice sixfold. During the World War cereal production was carried to still higher levels, rising in the case of wheat to more than 967,000,000 bushels in 1919. Production then, however, was stimulated abnormally, and the secular trend can be better indicated by pre-war figures. Our production of cotton in 1914 was 16,134,000 bales, compared with about 4,300,000 bales in 1875. Cattle increased in number from 25,620,000 in 1860 to 57,648,000 in 1890, but afterwards declined to 53,997,300 in 1910. Swine increased from 33,512,800 in 1860 to 58,185,600 in 1910. Production of wool in the United States in 1860 was 60,264,000 pounds; in 1910 the output was 289,419,000 pounds. After 1890, however, the increase in stock raising barely kept pace with the increase in population, and beef fell to an unimportant position in our export trade. How the poultry industry thrived is shown by the fact that production of eggs rose from 456,000,000 dozen in 1880 to 1,654,000,000 dozen in 1919.

Progress in animal husbandry was made through discoveries

in disease control and in genetics. In colonial times conditions for the livestock industries were ideal. The country was practically free from animal diseases. But with the importation of livestock from the Old World, this early advantage was lost. Livestock became infected with various dangerous diseases; soils became infested with parasites capable of spreading disease. Animal diseases were spread by the development of transportation and markets. Hog cholera, which made its appearance in this country in 1833, appeared in every State within twenty-five years. Texas fever entered the country in colonial times, apparently from the Spanish colonies, and was disseminated through the South in less than twenty years. Contagious pleuropneumonia, introduced from England in 1843, caused heavy damage before it was eradicated. Bovine tuberculosis was introduced from Europe in colonial times, and became a serious menace.

These diseases were eventually brought under partial or complete control by scientific methods, and the victories thus achieved facilitated the improvement of livestock through selective breeding. Few aspects of American agricultural history are more encouraging and inspiring than the development of the livestock industry through disease control and applied genetics.

Outstanding among the victories of science in livestock raising was the development of a successful immunization treatment against hog cholera. This plague in the sixties exacted from the relatively undeveloped hog industry a yearly toll estimated at more than $15,000,000. Later the annual losses ran up to $65,000,000. In bad years the disease swept away from 15 to 60 per cent. of the swine in some sections. Scientists in 1885 discovered a bacillus believed to be responsible for the disease, but further investigation showed that this germ was not the key to the mystery.

Finally, investigators in the Department of Agriculture ran down the enemy in the form of an invisible virus so small as to pass through the finest filters. This virus became the basis for the preparation of a serum which, when used in conjunction with the virus, gave hogs lasting immunity against hog

cholera. Thus the hog industry, not only of the United States but of the world, was saved millions a year. Neglect to apply the serum treatment is now the principal cause of hog cholera losses.

Even more striking in its ultimate value and results was the discovery that Texas fever in cattle is transmitted solely by a parasite. At first scientists scoffed at the idea, prevalent among cattlemen, that the tick had something to do with this disease. Many of them called the tick theory absurd. But in 1887 investigations were started which revealed the microörganism responsible for Texas fever, and proved that the organism attacks cattle only through the progeny of cattle ticks that have lived on infected animals. It was found also that infected immune cattle may carry the parasite in their blood a long time without showing any symptoms of the disease but nevertheless infecting ticks on their bodies. Transmission of such infected ticks to susceptible animals causes the disease to spread. Accordingly, on June 3, 1893, the first quarantine against Texas fever was established, and a method was devised of destroying ticks on cattle by dipping the animals in an arsenical bath. Systematic cattle tick eradication, started in 1906, eliminated Texas fever from a large area.

For the cattle industry this was a signal triumph; but its benefits were not confined to that business, for the discovery of the manner in which Texas fever is transmitted led to the control of serious human diseases. It had not been suspected, prior to the discovery of the cattle tick as the transmitting agent in Texas fever, that certain diseases attack their victims exclusively through a parasitic host or carrier of the causative germ. This discovery was consequently epochal in medical science. It led to the demonstration that yellow fever, malaria, typhus fever, and nagana are spread by parasitic hosts. It made possible the sanitary triumph which, by the control of yellow fever, enabled the Panama Canal to be constructed rapidly with comparatively little loss of life. The French failed in the undertaking, not through technical incompetency, but through not knowing how to cope with yellow fever.

The cattle industry also benefited greatly from tuberculosis

eradication work. Animal tuberculosis has never been as prevalent in the United States as in Europe, whence it was brought to this country in colonial times. Yet it costs the United States from $30,000,000 to $40,000,000 a year. Although no cure is known, diagnosis by the tuberculin test, discovered by Robert Koch in 1890, made it possible to separate diseased from healthy animals, and thus to check the spread of the disease. A campaign against bovine tuberculosis was started by Federal agencies in 1897, with the result that on July 1, 1926, the country had 1,557,087 cattle accredited free of tuberculosis, and 1,304,432 cattle that had been tested and accredited free of the disease in former years.

Other grave animal diseases, including foot-and-mouth disease, contagious pleuropneumonia, and European fowl pest, were eradicated by slaughter and quarantining. Contagious pleuropneumonia in cattle was stamped out in a five-year campaign that ended in 1892 and cost $1,509,100. But this expense was a trifle compared with the losses caused by the disease, not only in the death of animals but through embargoes set up in foreign markets against American cattle.

Control of hog cholera through immunization, control of Texas fever through tick destruction, and partial control of tuberculosis through eradication work, naturally stimulated the livestock industries. Livestock men imported choice animals from abroad with increased confidence, and interested themselves in selective breeding. As a result, the production of meat, butter, and milk increased greatly. To what extent meat production was facilitated by raising better stock cannot be estimated, because marketing practices changed greatly. At first animals were left on the range until they were eight or ten years old. A later practice was to market "baby beef," much of it less than two years old. Gains in productive efficiency therefore cannot be measured in terms of animals sold or pounds of meat produced. But selective breeding, coupled with better utilization of feed and earlier marketing, unquestionably yielded important economic results. Feed was saved, and more and better meat produced in less time. As for dairy production, we have significant recent evidence obtained by

the Department of Agriculture. From 1922-26, from only 4 per cent. more cows and heifers, about 20 per cent. more milk was produced than was produced from 1917-21, and the same period saw an increase of about 9 per cent. in the output of meat and animal products in relation to feed consumption.

These results show that the farmers had largely abandoned prejudice against "book-larnin'," and had come to appreciate the value of science. Every step taken toward better utilization of the soil involved the practical application of principles first demonstrated by scientific research and experiment. Nitrogen was furnished by manures and leguminous crops before the chemistry of the process was known. But when it was discovered that the soil should contain nitrogen, potassium, and phosphorus in certain proportions, a great stimulus was given to scientific soil preparation and cultivation.

Farmers also learned how to improve plants through selective breeding. From the bacteriologist and the chemist they acquired means of controlling certain fungus pests. They found that cereal smut can be checked by treating the seed with formaldehyde, and that with the use of calcium arsenate profitable crops of cotton can be raised in the presence of the boll weevil. Science enabled the farmers to develop strains of cereals capable of resisting rust and cold; to produce disease-resistant varieties of certain crops, such as Kanred wheat which resists stem rust; and to grow seedless fruits of increased size and improved flavor. It placed at their disposal many valuable plants from foreign countries, among them Durum wheat, the navel orange, Sudan grass, the alligator pear, the mango, the Chinese persimmon, the date, the papaya, the pistachio nut, and Egyptian cotton, not to mention scores of others.

The first important step in agricultural education was taken, significantly enough, during the Civil War. The Morrill Act, passed in 1862, gave to each State "as many times 30,000 acres of public land as it had senators and representatives." These lands were to be sold, the proceeds invested, and the interest devoted to the support of colleges of "agriculture and mechanic arts." Land grant colleges were established under the Morrill Act in every State, and also in Hawaii and Porto Rico. These

institutions conduct research work as well as agricultural instruction.

In 1887 Congress granted Federal support to the agricultural experiment stations and their influence became more important. The North Dakota station is credited with having added $10,000,000 a year to the wealth of that State for a decade by discoveries in cereal production. Passage of the Purnell Act in 1925 provided for an increase to $4,320,000 in the annual Federal endowment of experiment stations. More than six hundred new research projects were launched in the first year of the operation of the act. Colleges of agriculture in the United States in 1926 had an attendance of more than twelve thousand students. Under the Smith-Hughes Act Federal funds were granted to high schools for agricultural instruction. Nineteen states, moreover, required the teaching of agriculture in elementary schools. Nearly seven hundred thousand students of both sexes were enrolled in vocational agriculture courses in 1925. Through these agencies a fruitful alliance was established between the science and the practice of agriculture.

Increased efficiency, however, did not bring uninterrupted gains in the farmer's property. Production repeatedly exceeded market requirements, and readjustment processes were often drastic and prolonged. In 1819 a panic was precipitated in Europe and America by economic readjustments following the Napoleonic wars. American agricultural production had been expanded to meet the requirements of the warring nations, and the agricultural industry was therefore hard hit.

Change the dates and the production statistics, and you have a description that would fit the situation created by the post-war depression of 1921-22. Our sheep industry in 1919 was overexpanded and likewise our cereal production. Cotton growing, depressed during the war, was afterwards temporarily stimulated by European demand, and extensive land speculation took place. When prices fell, debt-burdened farmers were ruined and those remaining in the business found profits non-existent. A closer parallel between the situation then existing and the condition that developed precisely a century

later could scarcely be imagined. Relief came slowly through a readjustment between farm production and market requirements. Recovery was not well established until 1830.

Another panic presenting similar characteristics occurred in 1837. Shortly after the opening of the Erie Canal, farming expanded in excess of market requirements. Sales of land in 1836 amounted to twenty million acres. A halt was called in the usual way. Cotton fell from 17 cents to 10 cents a pound for export, and wool fell from 60 cents to 42 cents a pound. Short crops held up grain prices in 1836 and 1837, but they too fell disastrously in 1839. Agriculture became nearly as badly depressed as it had been in 1819. It was the same after the Civil War, with matters made worse by currency deflation. Farmers suffered intensely. While their income dropped calamitously, their outgo remained high. Taxes and interest rates were crushing, and high prices ruled for the things farmers had to buy.

This situation gave rise to the Granger movement, with its fervent political advocacy of agricultural interests. A burning issue was the fact that debt contracted in the war period at high prices had to be paid off from the sale of products at low prices. It did not simplify matters for agriculture when the Government began currency deflation. In addition to the major agricultural depressions of the nineteenth century, minor ones occurred from time to time through temporary overproduction, or through an expansion of acreage too rapid even for the world's rapidly expanding food requirements.

All previous experience of agricultural depression, however, was eclipsed by the crisis which developed after the World War of 1914 to 1918. This is too recent to need detailed description. Some of its outstanding features, however, may be usefully recalled. The depression struck American agriculture in a transition period, during which within a decade it had increased its production approximately 15 per cent. This was accomplished, not by an increase in the number of farm workers, but by increased efficiency.

In the depression of 1921 and 1922 farmers found themselves burdened with heavy supplies of grains and livestock,

and with a much expanded plant. Standards of living were perforce reduced, debts accumulated, and thousands of farmers became bankrupt or were continued in business merely by the leniency of their creditors. Farm bankruptcy cases in 1922 constituted 14 per cent. of all bankruptcy cases recorded in the country, compared with 5 per cent. in pre-war years. The farmer's plight was made worse by the fact that in the general collapse of prices the decline was greatest in the prices of farm commodities. In 1921 the purchasing power of farm commodities in terms of other goods, as measured by the United States Department of Agriculture, fell to 67 per cent. of what it had been in the period 1910 to 1914. Meantime, taxes increased and likewise tax delinquency. Taxes in 1923 absorbed almost 7 per cent. of the gross value of farm products, compared with 4.9 per cent. in 1913.

Moreover, relief came very slowly. From 1920 to 1924 the net income of American agriculture as a whole did not suffice to allow both a commercial return on the capital invested in the business, and a fair reward for the farm operator's labor, risk and management, although it showed gradual improvement. Gross income from all farm production in 1919-20, the last year of the post-war boom, amounted to $15,719,000,000. In 1921-22, the worst year of the depression period, it fell to $9,214,000,000, and thereafter rose to $12,760,000,000 in 1925-26. Simultaneously, farm production costs fell somewhat, chiefly through increased use of labor-saving appliances; and the net income of agriculture consequently increased in a somewhat greater degree than the degree in which the ratio between agricultural and industrial prices improved. Five years after the crisis, therefore, farmers were on the road to recovery. Nevertheless, their position remained unsatisfactory. Disparity persisted between the prices of farm products and the prices of other goods, and recovery was retarded through agricultural expansion in competing countries.

In this predicament the farmers turned for relief to technical progress, their ever-reliable support, and to coöperative marketing. Technical progress from 1920 to 1926 was more rapid than at any previous time. Accelerated mechanization, accom-

panied by a release for other uses of land formerly required to produce feed for workstock, was its chief characteristic. From January 1, 1920, to January 1, 1925, the number of tractors on farms increased from 246,000 to 506,000, adding fully 7,000,000 horsepower to the country's agricultural equipment. About 4,000,000 additional horsepower was added by an increase in the number of auto-trucks on farms, and 2,000,000 horsepower more by an increase in stationary gas engines. In the same period a decline in the number of horses and mules on farms released from 15,000,000 to 20,000,000 acres for other uses than the production of forage.

Stimulus to more efficient grain production was given by the introduction of a prairie type of combined harvester-thresher in the Great Plains east of the Rockies. This machine halved the cost of harvesting. It reduced the amount of labor required for harvesting and threshing four hundred acres from one hundred and twenty days of man labor to thirty days, besides shortening the harvesting and threshing period and reducing the waste of grain. In the newer cotton regions of Texas and Oklahoma large-scale production was facilitated by increased use of large power units. One man with a tractor often handled twice the acreage commonly handled by one man with four horses, and three-hundred-acre cotton farms became common.

Changes in crop production added to the efficiency of farming. Crop shifts were made toward crops with a higher acre value. In the Cotton Belt, for example, a shift took place from corn to cotton. In the western Corn Belt and in the spring wheat region a shift from wheat to corn took place. Through the use of drought-resistant and disease-resistant varieties of cereals, the area of corn and wheat cultivation was extended. In all these ways farmers strove to counteract the effect of unsatisfactory markets.

In the marketing field an enormous development of agricultural coöperation took place. More than 12,000 farmers' coöperative associations did business in 1926, compared with less than 6,000 in 1915. Agricultural coöperation in the ten years ended with 1925 increased in every section of the country,

except in a few out-of-the-way corners. The volume of business handled, measured in dollars, increased more than 1,000 per cent., and in 1925 exceeded $2,500,000,000. In that year more than 150 farmers' coöperative associations each handled a volume of business exceeding $1,000,000.

Although cotton and tobacco associations, as a result of consolidations, declined in number from 1915 to 1925, their membership increased more than 1,500 per cent. Cotton associations increased their business 9,887 per cent. in the ten-year period; tobacco associations recorded a business gain of nearly 1,300 per cent., and grain associations increased their business 159 per cent. Associations marketing dairy products handled 500 per cent. more business at the end of the ten years than at the beginning, and the number of livestock shipping associations increased more than 1,000 per cent.

This development was a logical approach to the solution of the surplus problem, the bane of agriculture, because through organization farmers can influence the volume of their production as well as the movement of their crops to markets.

Agricultural production can never be controlled with the nicety that is possible in industrial activities because the weather has at least a half interest in the result. Nevertheless, a better adjustment is possible than has been effected heretofore. Through economic information throwing light on probable market requirements, organizations of farmers have a means of influencing mass production which may become extremely important. For this reason the recent development of agricultural coöperation in the United States may be the precursor of a new era in agricultural prosperity.

In this rapid survey of agricultural progress during the last century much of importance has necessarily been omitted. It would be interesting, if space permitted, to discuss the influence of the Civil War on agricultural developments. That decisive event closed an epoch in southern agriculture, and opened one in western and northern agriculture. The war depressed the principal agricultural enterprises of the South, and stimulated those of the North; and its termination fixed the social conditions under which western expansion was to continue. Such

matters, however, lie outside the scope of a short survey. It would be interesting also to sketch the development of transportation in its relation to agriculture, and to glance at the rise of our great cotton and grain markets, and at some of the problems connected with that development. But it has seemed better to deal mainly with the technical progress and geographical expansion of agriculture, and with the broad economic basis of that development.

American agricultural progress in the last hundred years turned largely on two cardinal facts—first, the occupation of a virgin continent by a vigorous, intelligent people awake to the necessity of finding in technical progress a substitute for cheap labor; and second, a reciprocal relationship established between American agriculture and European industry. This relationship served the United States well for many decades. It permitted a specialization of economic functions between the continents which carried both forward more rapidly than would have been possible through enforced self-sufficiency.

As the period closed, however, the United States had become industrially independent of Europe to a very considerable extent, but was still heavily dependent on it as a market for foodstuffs. This dependence of agriculture on the European market—temporarily increased during the period of the World War—was a natural outcome of the conditions that existed during the nineteenth century. It was also, however, a principal cause of the farmer's distress in the post-war readjustment period. Its origin and the rôle it has played therefore assume high importance among the determining influences in American agricultural development. Our agricultural problems to-day are largely an outgrowth of the fact that the economic relationship between America and Europe is changing. In the twentieth century American agricultural prosperity will necessarily rest more on domestic than on foreign markets, and a grasp of what is involved should facilitate the transition process. If the testimony of the last century is any criterion, our farmers will tackle the job with intelligence and courage.

II

THE LUMBER INDUSTRY

By John W. Blodgett

Past President of the National Lumber Manufacturers' Association

IN the list of American industries, lumber is undoubtedly the oldest. Almost simultaneously with the coming of white settlers to this country, sawmills were erected in order to fashion from the dense primeval forests timbers and deals for the protection of the pioneers from the hostile natives and the bitter elements. Trees were then in abundance beyond utilization, and the problem of establishing clearings for cultivation was as imperative as that of providing shelter and protection.

Early records are at slight variance with respect to the first sawmill established on American soil. York, Maine, is credited by some with having had the first sawmill, in 1623, but Berwick in the same state claims the honor as of 1631; Cavalier Virginia contends for a vaguely earlier beginning and Dutch New York may have had mills in 1623. Necessarily primitive in their construction, these mills, and others in the early settlements, were the forerunners of the lumber industry of to-day.

The earliest American sawmills were copied from the mills of continental Europe, which had been operated both by windmill and water power for several centuries. Before the introduction of power saws, and even as late as the middle of the seventeenth century, sawing logs by the pit method was the only practice in England. This method, medieval in its crudity, consisted in one man standing in a pit beneath the log while another stood above it, working a long two-man saw. The development of sawmilling in England was retarded by the hand-sawyers, who felt that the introduction of power equip-

ment would put them out of business. Repeated attempts to establish power-driven sawmills in England were frustrated by riots. All the Colonial mills, however, were driven by water power. The first sawing machinery consisted of an upright saw in a frame driven by a connecting rod from a crank attached to one end of the water-wheel shaft. The log was moved against the saw by a pawl-and-rachet gear, driven by the same power as the saw, and timed with it. This type of sawmill, with slight variations, persisted for nearly two hundred years.

In the early settlements, authority for the establishment of a sawmill also prescribed the conditions of its operation. Sawmill grants in early New England provided "that in case any of the townsmen do bring any timber into the mill to be sawed, the owners of the mill shall saw it, whether it be in boards or planks, before they saw any of their own timber, and they are to have half for sawing of the other half. And in case any man of the town, that doth not bring any timber to the mill to be sawed, shall want any boards for his own particular use, the owner of the mill shall sell him boards for his own use, so many as he shall need, for the country pay, of three shillings and six pence an hundred inch sawn; but in case the men of the town do not supply the mill with timber to keep it at work the owners of the mill shall have liberty to make use of any timber upon the common to saw for their benefit."

Indeed much of the local legislation of the early New England town councils had to do with sawmills. There was little industry aside from farming, fishing and lumbering. It is interesting to note that even at this early stage, with almost endless forests at their command, the pioneers recognized the local value of tree conservation. In 1660 one of the towns in New England imposed a penalty of five shillings for every tree cut by the inhabitants from common lands except for their own buildings, fencing and firewood.

England, the mother country, early realized the value of the American forests. One of the colonial governors of New England informed the "Lords of Trade" that "the advantages that will redound to England by the right use of these planta-

tions are infinite and inestimable; not only tar and pitch, turpentine and oyle of turpentine and rozen, will be furnished, but also the deal boards, masts, yards and bowsprits, and all the larger sort of ship timber for the King and all his Dominions." In pursuance of this policy all large timber was marked with a broad arrow, signifying that it was reserved for the royal navy. The immediate result was a persistent quarrel between the settlers and the authorities that was one of the long-smoldering causes of the Revolution.

By the middle of the eighteenth century, almost every settlement had one or more sawmills. They generally carried one saw, attended by a man and a boy, and were sometimes able to turn out about 2,000 feet of boards in twelve hours. Production was mostly for local consumption, although an export trade in lumber, masts, boards and staves, rapidly was developing with the West Indies and the Canary Islands. The shipbuilding industry by this time had gained considerable headway, and the French and the Spaniards were buying masts poached from the broad-arrow reserves, and American-made ships, for which they paid in rum, molasses, wines and silks. The substance of the early foreign trade of New England was the products of the forests. The forests sheltered the colonists at home and enabled them to buy from abroad both necessities and luxuries.

The lumber industry did not attain great proportions, either as to size of individual operation or total output, until well along in the nineteenth century. As late as 1840 the total annual lumber production of the United States did not exceed one billion feet as contrasted with more than forty billion feet seventy-five years later.

Up to 1850 the industry was very largely confined to the Eastern States. The center of population, as well as the center of industry, still was near the Atlantic Seaboard, and the vast timber resources of the Lake States and the Upper Mississippi River were as yet almost untouched industrially. Maine since the earliest operations had held the premier position as a lumber producing state, turning her stands of White and Norway Pine into lumber and ships. In 1841 two thou-

sand men were employed, and $4,000,000 invested in her lumber industries. In that year the "Pine Tree" State manufactured 200,000,000 board feet of lumber valued at $2,000,000, or an average value of $10 per thousand feet.

From the time of the earliest Maine mills up to 1855 it was estimated that approximately 3,200,000,000 board feet of pine were taken from her forests.

As the more accessible stands of timber became denuded, and the consuming centers shifted, Maine began to lose her supremacy in the lumber field, and by 1850 the heart of the industry had moved to the Adirondack forests in the state of New York. Lumbering in the Empire State had been carried on, however, for more than two centuries before leadership was wrested from the then celebrated "Pine Tree" State.

With the westward passing of the center of the industry many Maine lumbermen moved with it, acquiring timber lands in New York from holders of early colonial grants. About that time the "gang" saw came into general use, enabling the mills to greatly increase the amount of their output. Essentially the gang saw is but an extension of the old upright saw —many parallel saws being held by a sturdy frame, so that many boards can be sawed at once. New York was soon producing about 20 per cent. of the country's annual production, of about eight billion feet, which had increased 700 per cent. in ten years.

In the South the beginnings of what later was to become the great Yellow Pine industry had already taken shape. Virginia was producing large quantities of oak, and the Carolinas and other Southern states had developed an important trade in Yellow Pine and naval stores.

These earlier lumber developments were usually located on streams for the purpose of floating logs to the mills, rafting the lumber and for the utilization of water power. In fact, the industry's history is linked with rivers, and the early lumberjacks were generally industrial amphibians. The St. Croix, Kennebec, Penobscot, Androscoggin, Merrimac, Connecticut, Hudson and Lake Champlain waters; the Susquehanna, Allegheny, and the Great Lakes rivers, the Wisconsin, Chippewa,

and the Upper Mississippi, mark successive westward marches of this characteristically migratory industry.

It might here be said that there is naturally an underlying economic reason for this migration. The raw material of the sawmill is the saw log—a commodity so bulky, with a product so cheap in price, that the cost of log transportation for any distance is economically unbearable and prohibitive. Therefore, unlike other manufacturing industries, the factory must be taken to the raw material, instead of the raw material being taken to the factory. Furthermore, this raw material comes from trees from one to five centuries old, and is not the product of an annual crop.

Hence the erection of a modern sawmill plant, ofttimes costing millions of dollars, must be preceded by the acquisition of sufficient adjacent timber lands to supply the mill for many years. Otherwise a sawmill investment would be hazardous in the extreme, as it would be at the mercy of the owners of adjoining timber from whom it must get its supply of raw material. With its entire supply of raw material purchased many years in advance, a lumber operation therefore really is but a process of gradual liquidation, differing therein fundamentally from the usual manufacturing enterprise.

In the early stages of its development, the lumber industry marched with the extension of the settlements. Lumber was manufactured for the most part for local consumption, and it was the naturally indicated material of which the settlers should build their houses and other edifices. In 1849, in the mad rush to the Pacific Coast, the gold seekers of California also found wealth in the giant forests of that territory, and lumbering leapt across the continent. The Forty-niners built their cities and homes of the Redwood of California; and drawing also on the Douglas Fir forests of the "Oregon country," thus started the lumber industry on the Pacific Coast.

With the constantly increasing population and the gradual westward movement from the Alleghenies new sources of timber supply were successively brought into use. By 1860 the center of the lumber industry had moved south into Pennsylvania, whose White Pine forests supplied the bulk of the

building material for the Eastern States for the succeeding decade. The rapid settlement of the Middle West, just before and after the Civil War, again caused a shift in the center of lumber production. The forests of the Lake States began producing large quantities of lumber needed in the occupation of the new prairie and plains country. The first sawmill in Michigan was established in the Saginaw Valley as early as 1832. In those days good White Pine could be bought at the mill at $4 per thousand feet, and densely timbered tracts were obtainable at the rate of $1 per acre, an acre containing from 10,000 to 40,000 board feet of White Pine.

"By 1850," says Frank Rickaby in his "Ballads and Songs of the Shanty-Boy," "the steam-driven circular saw had supplanted the primitive water-power jig-saw and the supremacy in lumber production had moved successively from New England to New York, and from New York to Pennsylvania. The Army of the Axes had advanced even into the awe-inspiring columned vastnesses of Michigan, and across the intervening lake into the illimitable pineries of Wisconsin. What had previously been a steadily growing call for lumber, by 1870 swept suddenly upward into a reverberating clamorous roar of demand, as the hundreds of thousands, following the Argonauts of '49, surged out into the New West. It was then that American lumbering literally leaped into its Golden Age. Over Michigan, Wisconsin and Minnesota hovered for thirty years the far-seen glow of its romantic climax. Immense fortunes fell into the hands of far-sighted men, as into the spring-swollen streams rolled billions upon billions of logs, and the land was sown with stumps."

Thousands of logging camps fed booming lumber towns and cities. The scepter of lumber empire passed from Albany and Tonawanda, New York, to Williamsport, in Pennsylvania; to Saginaw and Muskegon, in Michigan; to Eau Claire and Chippewa Falls in Wisconsin; to Minneapolis and Duluth in Minnesota.

As the industry moved westward, it brought settlement, trade, road and railway building, and navigation of the rivers and lakes. As the pines fell, the new states blossomed with

industrial life, and from the exploitation of the forests arose populous commonwealths.

The industry flourished greatly in Michigan, Wisconsin and Minnesota, and the lumbermen proceeded in the handling of their forests on the confident assumption that they were so vast as to be inexhaustible. In 1873 these states produced almost 4,000,000,000 board feet of lumber, virtually all of which was White Pine. For the next twenty years the lake region was the chief lumber producing section of the country, supplying, in 1890, 8,597,623,000 feet of White Pine. By then the myth of inexhaustibility was exploded, and it was evident that the supply of White Pine was being depleted. Once again the migratory industry began to look to the other fields. Coincidentally with the passing of the Lake States as the great producing center also passed the supremacy of the superb White Pine—*Pinus strobus*—as the principal timber tree of the American forests. It had held sway for 250 years, but was destined to give way to the Yellow Pine found in the luxuriant coastal plain forests of the South. Its passing was one of high fame, for White Pine lumber housed the epochal settlement of the states of the vast and fertile prairies and plains of the Mississippi and Missouri valleys. Civilization almost literally advanced on White Pine from the Great Lakes to the Rocky Mountains. Without it the final occupation of the West might have been set back several decades.

With the original White Pine passed also one of the most characteristic and picturesque human elements in the great spectacle of the growth and development of the United States. In no other region did the lumberjack or the shanty-boy rise to such distinction. What the cowboy was to the plains, the old-time lumberjack was to the forests of the North. He was a sample of elemental humanity in the bosom of modern civilization. Singing, swearing, fighting, carousing; defying cold and storm, loving the wilderness he subdued; he was truly among the founders of the nation.

The history of the lumber industry abounds in romance, and has formed the background for many stirring volumes of fiction. Life in the forest has ever appealed to the primitive

nature of man. The hardy woodsmen were no exception, and out of their continuous communion with the wilderness has grown the one American myth, the myth of Paul Bunyan and "Babe," his mammoth blue ox. Dream child of a thousand logging camps, Paul Bunyan, the colossal wonder worker of the stupendously ridiculous and the ridiculously stupendous, is the personal caricature of the lumber industry. It is the Hercules of American industries, restless, superbly venturesome, striding across the continent; the pioneer of industrial life, blazing forest trails, building roads through dense woodlands, subduing rivers and lakes to the yoke of navigation, providing the material for shelter for millions, and for countless industries; converting a wilderness product into fixed and liquid capital, and thus founding commerce and finance.

With the shift of the lumber center to the South, every remaining timbered section of the country began attracting the attention of lumbermen and investors in timber resources. The transcontinental railroads were the means of opening up vast areas in the West. They acquired extensive land grants from the government and disposed of them to lumbermen and timber investors. Before 1800 virtually all of the land west of the Appalachian and Allegheny Mountains, and much of the land in the Eastern States, was public property. The Louisiana Purchase region and the Mexican cessions were almost entirely public domain. It was the policy of the Federal Government and the states to dispose of these holdings on liberal terms in order to encourage settlement and development of new territory. As a result of this policy, most of the choice timberlands in the country eventually passed into private hands. Formerly forests were not valued highly; rather were they considered obstacles to the march of civilization across the continent; the pioneers prized a clear tract above a dense forest. It was generally thought that most timbered land would pass from lumbering to farming. For a long time the forestry problem was how to deforest rapidly, instead of reforest.

In the last twenty-five years lumber manufacturing on a large scale has been transferred to the country's last great stand of virgin timber in the Pacific Northwest. At the be-

ginning of the present century this region began supplying lumber in such abundance as to place Douglas Fir lumber in the forefront of products of the American forests. The opening of the Panama Canal gave the lumbermen of the Pacific Coast access to the great markets of the Atlantic seaboard. In 1920 more than 35 per cent. of the Nation's total lumber was Fir and its allied woods—Spruce and Cedar. This far Northwest region to-day is the scene of many of the largest and most important lumber operations, and its material prosperity is mainly founded on lumber. Tacoma, Portland, Seattle, Bellingham, Everett, Aberdeen, Longview and other cities have become the capitals of the wandering industry, which has rallied there from East, North and South.

This wonderful Western territory contains not only the last but the most magnificent of our original forests. Here are the pines of the Sierras, the gigantic Redwoods, and the wonderful fir and spruce trees of Oregon and Washington, and the Pondosa and Idaho white pine of the "Inland Empire." Here will probably always be the principal source of lumber supply for the United States. Before its present magnificent timber stands are exhausted, the people will surely have taken advantage of a soil and climate so perfectly adapted for the purpose, and will have grown another timber crop.

The lumber industry, as we have seen, started on the Atlantic, and has, by various and zigzag steps, crossed the continent to the Pacific. Always one of our leading activities, and an essential element in our national development, it has naturally kept step with the growth of the country.

To-day lumber and allied woodworking industries employ more than one million men, and approximately one-twelfth of the population of the country is dependent upon these industries for their livelihood. They represent an investment of more than twelve billion dollars. About 17 per cent. (more than a sixth) of the total available capital of the nation is invested in forests and the instrumentalities for their conversion into the myriad forms which we demand for some 4,000 uses. The lumber industry was and is an integral part of

our national life. Lumber or wood is a basic or important element in 60 per cent. of our industries, and the exhaustion of the supply would be a national calamity.

The production of lumber involves two major processes,—logging and milling. Logging (the most picturesque phase of the lumber industry) includes the severing of the tree from the stump, cutting the merchantable part of its body into saw logs and transporting them to navigable water or direct to the sawmill. "Milling" is the conversion of the saw log into the great number of sizes and lengths of lumber and timber required by our myriad wood-using industries.

Lumber, like other American industries, has continually improved and advanced in its production processes, due to American enterprise and inventive genius. In the early days of logging, oxen or horses and usually heavy bob-sleds were used to haul the logs from the woods to the mill or to the stream into which they floated them. Operations usually did not start in the north until snow had fallen, when the logs were dragged over ice or snow roads and discharged into the frozen streams. With the arrival of spring thaws they were then driven down the stream to the mill.

Modern logging, however, is a vastly different process. In the work of moving the tree from the place where it is felled and "bucked" into logs to the carrier that conveys it from the forest to the mill or stream, modern mechanical process has very largely succeeded animal power. Stationary or "donkey" engines operated by steam or electricity are very generally used, especially in heavy timber, to "skid" or assemble the logs. By means of wire cables, winding on drums, these engines drag heavy logs on the ground or swing them through the air with the assistance of aerial trolleys for distances up to a half mile. Automobile trucks and tractors, steam traction engines and steam skidders are also frequently used. The hugest and heaviest logs are quickly manipulated by these mechanical slaves of various types. No successful mechanical device has as yet been brought forward for the purpose of felling trees, for which purpose axes and saws wielded by robust experts

are still in general use. It can, however, be confidently predicted that American inventive genius will soon provide a mechanical faller.

Water transport is still one of the important methods of conveying logs from the forest to the mills, although the logging railway plays the major part. Indeed, within the lumber industry there are logging railroads comprising 30,000 miles of track,—more mileage than the entire common carrier railway system in France.

In the Pacific Northwest these logging railways usually lead to tidal waters on the lower Columbia River, Puget Sound, and the protected coastal waters of British Columbia. The greater part of the enormous log output of these regions is made into rafts at the water's edge, which are then towed by powerful tugs sometimes for hundreds of miles to the various sawmills.

The improvement of the logging camp itself has been one of the most marked and pleasant phases of the American industrial life. The most modern camps are actually or virtually villages on logging railway cars, which are moved forward and onward into the forests as the trees fall before the sharp axes and bright saws of the woodsmen. These camps are neat and sanitary and provide a degree of luxury unknown to most workers in other industries. They include cars for sleeping, for kitchen, and for dining, and are provided with shower baths and other niceties of modern civilization.

The logger is engaged in strenuous physical work and requires from 5,000 to 8,000 calories a day (in contrast with the normal adult requirement of 3,000 calories) to keep him in fit condition for his job. Camp fare, like the sanitary living condition, has been vastly improved from that of a generation ago. A typical breakfast in the modern logging camp includes unlimited quantities of cooked cereal, with milk and cream, bacon or chops, eggs, biscuit, potatoes, milk or coffee, doughnuts and griddle cakes. Fifty years ago the fare consisted almost solely of salt pork, beans, tea and molasses. In some of the California mountains, where camps operate in the summer only, loggers take their families with them for the season. The families of these "lumberjacks" look forward to these

outings with as much pleasure as some people anticipate a trip abroad.

The processes of saw milling, due to American inventive genius, have improved and kept abreast of the growth of the industry. In contrast to the small mill of the early days with its single upright saw, a modern sawmill plant is a large establishment, representing an investment of a number of millions of dollars, and producing in some cases as much as 1,200,000 board feet of lumber a day, equivalent to a freight train of fifty carloads. It is equipped with band saws, gang saws, re-saws, edgers, trimmers and a variety of other machinery used in the conversion of the log into lumber. Because sawmill offal is an admirable fuel, the motive power nowadays is steam or steam-electric. Sawing is now almost entirely mechanical and the machinery is all a heavy type, made of the most durable materials. Formerly lumber was sold "in the rough" as it came from the sawmill and planed by hand. To-day all modern plants have in connection therewith planing mills which plane the rough lumber and further refine it into flooring, ceiling, siding, moldings, etc. Many sawmill plants also include box factories, shingle mills and lath mills, in which is utilized material which otherwise would go to waste.

In the last decade of the nineteenth century the practice of kiln-drying lumber, especially softwood, came into general adoption. Prior to that time lumber was seasoned for final use by the much more tedious process of air-drying. While the kiln method requires but two or three days, air-drying is a matter of months. Air-drying is accomplished by piling the lumber on the millyard in such a manner that every piece has adequate ventilation until thoroughly dried. In kiln-drying, the lumber is placed in steam-heated kilns in which it is subjected to degrees of heat and moisture scientifically determined, according to the wood and its thickness. The air-drying process still is used, many of the hardwood mills employing a combination of the two processes; that is, the lumber is treated by air-drying and, later, finished to the desired moisture content in dry kilns.

The modern sawmill to-day creates and maintains a small

city. Including timber lands, sawmills, railways, logging equipment and accessories, a lumber company usually has a total investment of many millions for a single operation.

There are now approximately 30,000 sawmills in operation in the United States; the majority, in number, however, are small portable mills, crudely equipped and usually worked on small tracts of second growth or inferior timber. The present tendency is toward large sawmill units, because of their ability to produce more cheaply, make better lumber and to prepare it properly for the world's markets. The census of manufacturers in 1919 showed that 1,290 mills or 5.7 per cent. of the total number in operation in that year produced 70.7 per cent. of the total lumber cut. This clearly indicates the concentration of lumber production by the use of the larger and more efficient units. The improvements in the methods of logging and manufacturing are constantly resulting in a more intensive utilization of the forest.

The National Committee on Wood Utilization, a semi-public organization affiliated with the Department of Commerce, is the outgrowth of a conference called by President Coolidge in 1924, in the interest of conservation of timber resources. This organization is functioning with the support and coöperation of the lumber and wood-using industries, and its accomplishments are of great importance to the American people, both in better conservation of forests—thereby prolonging our present timber supply—and also in cheapening the cost of production through more complete utilization of the raw materials. "Use wood and conserve the forests," which at first might seem contradictory, is truly axiomatic.

In the early stages of the industry, hardwoods,—the products of the "broad leaf" trees as distinguished from the needle leaf or coniferous trees,—received little attention. Even in the Lake States, where there were large stands of maple, elm and birch, these woods were ignored by the early lumber manufacturers. With the development of many uses for hardwoods, the hardwood branch of the industry took on a sudden growth, developing methods, practices and a trade terminology all its own.

Softwoods are used chiefly as structural material, while hardwoods find their greatest use in the woodworking industries. Another point differentiating the two branches of the industry is their methods of distributing their products. Softwood lumber usually is marketed through lumber dealers who retail their commodity to building contractors and other consumers. Hardwoods, on the other hand, ordinarily are marketed to the 60-odd groups of woodworking industries, such as furniture and implement manufacturers, musical instrument makers, etc. Hardwood lumber, except as flooring and interior trim, rarely reaches the consumer through the medium of a retail dealer.

American sawmills produce more than one-half of the total lumber cut of the world, all of which, with the exception of about 7 per cent., is consumed in the domestic markets. The peak of the lumber production to date was attained in 1907, when the total output was 46,000,000,000 feet; it is now under 40,000,000,000.

Like practically all of our industries, lumber finds by far its greatest market at home. In fact, the United States is the largest user of wood in the world. We use more than half of all the saw timber consumed by the world, our per capita consumption of lumber being over 300 feet per year, as compared with less than 50 feet per capita in Europe. Our high standards of living are admittedly due in no small part to our free use of wood.

The export trade in lumber, while but a small part of the total output, has been and still is a considerable factor in our foreign business. As before stated, it began before the birth of the Republic, and has increasingly persisted. Our leading export markets for American lumber to-day are Japan, China, Australia, Western Europe, Great Britain, the West Indies, South America, and Mexico.

American lumber in recent years has played an important part in the rebuilding of devastated Europe, and earthquake-ridden portions of the Orient. We are now exporting approximately 7 per cent. of our total output, and reached our greatest volume in 1913, when we sent abroad nearly three and one-half

billion feet of lumber and lumber products, valued at $114,777,513.

Surprising, however, as it may seem, the United States imports large quantities of lumber. In 1926 we imported 1,777,000,000 feet of softwood lumber, valued at $48,775,818. Most of this lumber came from Canada and was an importation resulting from contiguity rather than necessity, lumber being duty free. In addition, we import considerable quantities of mahogany and other tropical woods chiefly used in the manufacture of furniture. The total value of our wood imports in 1926 was $101,910,887.

The progress of the lumber industry has been assisted by efficient and beneficial group organizations. Within the first decade of this century there came into existence trade associations of lumber manufacturers, of wholesalers, of retailers, and of exporters, to better their methods and widen their markets. These organizations have been largely responsible for the rapid strides made by the industry within recent years.

Broadly speaking, probably the greatest commercial advances in the lumber industry have been made within the last ten years. Lumbermen have become conscious of their position in the economic scheme of things and have translated their dealings in terms not only of dollars and cents but also in terms of benefit to the public of this and future generations. I refer specifically to the movements for standardizing the manufacture of lumber, and for the elimination of waste in manufacture.

In 1922, representative manufacturers, dealers, consumers, and others interested in the use, distribution or manufacture of lumber met in Washington with the Hon. Herbert Hoover, Secretary of Commerce, and formulated a program looking to the simplification of lumber-grading standards, greater uniformity in grades of competing species, standardization of sizes and the development of more adequate quality guaranties to the lumber-using public. After numerous meetings and conferences extending over a period of four years, the coöperating lumber groups evolved a program of softwood lumber stan-

dardization. The hardwood manufacturers are now working toward the same goal.

The importance of standardization in lumber manufacture cannot be overestimated. Secretary Hoover described it as "one of the outstanding demonstrations of the possible accomplishment of voluntary organized industry in the United States." It has reduced the cost of manufacture and the cost of distribution. It has reduced waste and cost to the consumer. It has tended to stabilize industry and to increase employment.

By the elimination of unnecessary and often wasteful sizes, the actual number of retail yard lumber items has been reduced by nearly 60 per cent. Such simplification of business practice means economies of great magnitude. It has been estimated that the waste already eliminated by this work runs into tens of millions of dollars annually. Secretary Hoover referred to this saving as being "just as important to the public as a reduction of taxes." In his words, uttered at the opening of the Fifth General Conference on Lumber Standardization in 1925: "Here is one of the largest of our industries taking a leadership in the improvement of the most complex and technical of trade practices; doing it at the hands of men actually in the business itself, and doing it with a resolution that it is up to the industry to demonstrate its full purpose as a part of our national life. Above all, it is accomplishing these ends by voluntary action, not by the extension of law. I am convinced that if your difficult problem can be fought out on this line you will have demonstrated that our business problems can be solved better in public interest by industry itself than by Government regulation."

More important, perhaps, than the benefits to the industry of the technical changes in the manufacture of sizes and grades of lumber are the benefits accruing to the home builders of America. Lumber standards, as adopted by the industry, assure them of a uniformly high quality of material. They represent guaranties of quality and fair dealing, and are a protection against fraud, and high prices resulting from wasteful methods in manufacture.

Millions of dollars are expended annually from public and private funds for the protection of forests against fires. Yet the annual property loss from forest fires is estimated at $25,000,000. On an average there are 50,000 forest fires each year which cover over 10,000,000 acres, but this area is largely cut-over and generally previously burned-over land. At least 50 per cent. of these fires are believed to be caused by carelessness of visitors or trespassers in the public or private forests. The state and national forest services; the American Forestry Association, the American Tree Association; the Western Forestry and Conservation Association; and other forest industry organizations; the American Forest Week Committee, an organization of recent creation, and numerous other bodies have undertaken to arouse the American people to forest fire-consciousness. Through the press, the radio and from the platform they have waged a vigorous campaign of education with a view to the minimization of forest fires and the conservation of the timber supply, and American Forest Week has become a national institution.

We have briefly sketched the physical, mechanical and economic history of the American Lumber Industry. What can be said of its future? Our lumber industry is obviously dependent upon the timber supply. During the three centuries of forest utilization now closing, our wood-using industries have been supplied from the stored-up forests of half a continent,—from forests which no man grew and which cost nothing to produce. While we have still a large area of these primeval forests (and about 40 per cent. as much standing saw-timber as a century ago) we are consuming them, our experts advise us, much faster than the annual regrowth. Obviously therefore this nation may in time face a comparative timber scarcity, and yet, until recently, reforestation has been but an academic question. Our forests were and still are, all things considered, the greatest forests in the world, economically viewed. They compose a hundred commercial species and more volume of material than any other forests within national boundaries, except those of Russia.

Our forests are the only natural resource the supply of

which can be definitely ascertained. *They are the only natural resource that can be reproduced.* Time is the chief element involved in this reproduction, and it is generally admitted that we must now take action if we expect to avoid a gap between the exhaustion of the virgin forests and the regrowth of new ones.

Let us survey our situation. The United States Forest Service says that we have approximately 470,000,000 acres of potential forest lands, and that if this area is kept in forest production the annual growth will equal the present draft upon our forests. Much of this vast area has been cut over and its productivity reduced or destroyed by repeated fires, and but little of it has been put back into the use to which nature dedicated it. Why this situation? We all know that American initiative, energy and capital quickly exploit every opportunity that offers returns upon the time and money invested. Yet this field is untouched. The conclusion is irresistible therefore that reforestation of big timber by private capital is not and has not been economically possible. The continuous hazard of fire and the pyramiding of annual taxes are enough to keep private capital away, but added to these is the insuperable barrier of the long time necessary to produce mature big timber. Clearly we cannot hope that private enterprise will undertake reforestation to the extent necessary to provide a perpetual timber supply for this nation. Where then shall we turn? The only other possible reforesting agencies are the states and the Federal Government.

The states are already burdened with debts and with heavy taxation, and we can hardly hope that they will undertake reforestation on an adequate scale—in fact, results to date make it certain that they will not. Upon the nation then must rest the major part of the burden of providing a future supply of this essential natural resource. This conclusion is entirely equitable, for it is a national need that must be met. Federal responsibility is now being recognized by those whose public duties bring them face to face with our forest situation. The Secretary of Agriculture in his annual report for 1927 said, "To assume that the country's forest problem is virtually

solved, and that it will work itself out shortly as a matter of industrial evolution would be a serious mistake. The situation demands a larger program of public action than has yet been entered upon."

Congress, through the enactment of the Weeks law in 1911, the Clarke-McNary Act of 1924, and certain pending legislation, has shown itself awake to the necessity of immediate action. The difficulty lies in the fact that the public is not informed, and is supinely waiting for private enterprise to complete the task. Private enterprise has never completed such a task in any modern country.

The Federal Government, in its National Forest reserves, now owns about one-fourth of our mature timber. It has an organization with the necessary technical knowledge to carry on the work which it has begun on a comparatively small scale. It only needs enlightened public opinion to authorize it to enlarge its operations to the necessary extent.

The states can and should aid. Pyramided heavy annual taxes are forcing the conversion of virgin forests faster than the nation's needs require, and offer an almost insuperable barrier to private reforestation. Quoting again from the last report of the Secretary of Agriculture: "The greatest obstacle to more rapid progress in forestry in the West is the fact that altogether too much mature timber is seeking a market through manufacture. The immense volume of stumpage in private hands creates a pressure to liquidate which makes the underlying economic condition of the lumber industry in that region unstable. What is needed more than any other one thing in practically all parts of the West is relief from this pressure."

Reform in timber taxation and better fire protection may induce a degree of individual reforestation, especially for the production of paper pulpwood, which requires but a comparatively young tree. To the extent that such enterprise becomes general the nation will be relieved of its task. In the meantime, however, it should proceed as energetically with the growing and renewal of the forests. They were a factor of first importance in the upbuilding of this Republic, and their perpetuation is just as essential to its future growth and prosperity. Vast

areas of America that are not agriculturally available are capable of yielding us forever annual timber crops greater than any that have been reaped. If the rewards are not sufficient to furnish incentive to private capital and initiative to produce this crop of wood the state must enter the breach. America cannot afford to become a deforested country—it has too much land fit only for forest.

III

SHIPS AND SHIPPING

By Edward N. Hurley

War-time Chairman, United States Shipping Board

IT is a sad commentary upon American genius, enterprise and resourcefulness, that during the past century the building of ships and their profitable use in expanding our trade in foreign markets, has not always kept pace with our development in other lines of commercial activity.

While it is true that we still have the second largest mercantile fleet in the world, the major part of our deep-sea tonnage even now, notwithstanding its tremendous expansion as a result of the Great War, is employed, not in transporting our products to foreign countries and in bringing home the materials and supplies which are essential to our prosperity, but rather in the protected zones from which all foreign flags are excluded.

During most of the century past, the greater part of our tonnage has been engaged in the coastwise trade and the commerce of the Great Lakes. Down to the time of the war between the states the disparity between the amount of tonnage in the foreign trade and that used in the domestic trade was not marked. From that time on, however, tonnage in the foreign trade steadily decreased while in the domestic trade it as steadily increased, until just before the outbreak of the European War we had eight times as much tonnage in the coastwise and lake trade as in foreign commerce.

Although at the present time there is a greater volume of tonnage, represented in ships in excess of 1,000 tons, documented for foreign trade, than there is like tonnage documented for domestic trade, still the tonnage actually employed in

domestic trade is substantially in excess of that employed in foreign trade, because of the number of idle ships belonging to the government.

Relatively speaking our deep seagoing fleet, when compared with the deep seagoing fleets of other nations, was superior one hundred years ago to what it is to-day. Then, 89 per cent. of our foreign trade was carried in American bottoms. To-day, augmented by the construction begun after we had declared war against Germany, 32 per cent. of our combined exports and imports are transported in vessels that fly our flag. Just before the war in Europe started only about 8 per cent. of our foreign trade was carried by American ships.

In the arts and sciences, in the development of natural resources, in invention, in manufacturing, in agriculture, in finance, in industry and progress generally, we can proudly boast that we have outstripped all competitors, but in the building of ships and their successful operation in trade with foreign countries, we have fallen behind the maritime nations of the world, relatively, and in some cases actually.

We have taken a commendable and warranted pride in our accomplishments in other directions, but our failure as a maritime power must be confessed with embarrassment and sorrow. The reasons for this unfortunate situation are not difficult to assign, but they only afford an excuse; they neither give us cheer nor atone for our lack of success. They are merely explanations which do not satisfy our desires or relieve our humiliation.

The year 1828 opened auspiciously for the American merchant marine. Our shipping was in excess of three-quarters of a million tons. While this was somewhat less than it had been just prior to our second war against England, it nevertheless represented almost as much in total of foreign commerce transported as did the ships of the prior period.

The policy of discriminating duties had been abolished and we had entered upon a period of ship reciprocity which was intended to mean that our ships should enjoy the same trade privileges in the ports of the world that were accorded to the ships of other nations. Our government and our ship owners

were prepared to adhere faithfully to this principle, and did so, although it was with reluctance and delay, and at times with appearance of insincerity that some of our maritime competitors, notably Great Britain and Spain, accepted the doctrine. On the whole there existed no restrictive embargoes or hostile decrees.

Piracy, which for so long had been a menace to the peaceful pursuits of the merchantmen of every civilized nation, had been practically banished from the seas, our own navy having been largely responsible for its annihilation along the Spanish Main.

The world at large was at peace, following many years of intermittent strife, and our own country was getting itself into a condition where it could enjoy an era of prosperity. There was a little slump in our ship building and in our shipping for about two years before a revival of commercial activity in Europe set in, but when it did make appearance it found our people prepared to take advantage of it. Increased foreign commerce meant more ships,—bigger and better and swifter ships, and with the training and experience which our shipbuilders had had for more than two generations, they were in a position to provide them. With the exception of a slight depression for a short time, as a result of the panic of 1837, due to causes not allied with world trade, they continued to provide bigger and better and swifter ships in ever increasing numbers and tonnage, for the ensuing thirty years, or down to the time of the outbreak of war between the states.

Throughout the thirties our maritime supremacy was maintained by the noble fleet of packet ships with which our rivals on the sea were never able to compete, in design and construction, in cost of building or in cost of operation. They were first introduced shortly after the close of the War of 1812, and had become well established before the period mentioned. They were built chiefly for the North Atlantic trade and, of necessity, had to be strong of hull with a moderate height of spars and spread of sail. They had the required bluffness and freeboard to enable them to withstand the heavy weather of the route which they traversed, but their under-water bodies had almost the fineness of yachts. The packets wrought a

revolution in transatlantic traffic. They were intended to establish, and did establish, for the first time in the seafaring experience of the world, regular lines for the transportation of passengers and mails, as well as freight. They sailed between American and English and French ports on predetermined schedules. They had fixed dates of departure, and while the time of arrival at their destinations varied somewhat according to the conditions of wind and weather, they nevertheless maintained regular service. In fact, their average adherence to schedules was not approached, even by steam vessels, until many years afterwards.

It was for this reason, as well as their greater speed,—although they were slower than the average clippers which followed them upon the sea,—that the comparatively few transatlantic voyagers of those days sought passage upon them, so far as was possible. Although the cabins were small as compared with modern standards, the first class accommodations were not uncomfortable, especially in pleasant weather, and they exceeded anything that sea travelers had before known. It was only the poor immigrants who experienced discomfiture aboard them. When there was a storm at sea the hatches were clapped down and they were huddled between decks where the ventilation was very bad and where they were forced to remain, enduring more or less suffering, until the skies cleared and the wrath of the sea subsided. The ancestors of many distinguished Americans of to-day, however, withstood these conditions for the privilege of founding new homes in the land of freedom.

Europe, not even Great Britain, could produce anything which could successfully cope with these packets, and made only feeble attempt to do so. At a time when a five-hundred-ton sailing vessel, fully equipped (later many of them were much larger), could be built in this country for $37,500, the cost of a ship of similar tonnage in England was $43,000. In addition to the superior sailing qualities of American vessels, this was a potent reason why British owners reached the conclusion that the British sailing ship was outclassed. Furthermore, the advantage in the cost of operating such a vessel was

decidedly in favor of the American ships. Where the cost involved in operating a 500-ton American ship was around $11,000 annually, the expense to a British vessel of similar size was in excess of $13,000 a year, notwithstanding the fact that wages in the American merchant marine were uniformly higher than on British ships. These conditions account for the fact that during a period of a quarter of a century ending in the thirties, American shipbuilders sold abroad 340,000 tons of American built ships, most of them of the packet type. In this way, the foreigners, and especially the British, were able, in a measure, to reduce the odds against themselves in the competitive trades, while they were marking time and developing steam as a motive power, which, although it had originated in America, and had been successfully employed on our river boats, was, for the time, neglected by our American builders, so far as deep sea navigation was concerned.

Unfortunately, for the welfare of the shipbuilding industry, our shipwrights of that day while building larger, better and faster packets, until they attained their triumph in the famous clipper ship, continued to adhere to sails as a means of propulsion.

The first and perhaps the most noteworthy of the packets was the Black Ball line. Soon there were three lines sailing out of New York, two for Liverpool and one for Hull; later half a dozen or more others were established running out of New York, Philadelphia and Boston to Havre, London and to Liverpool.

The development of the packet ships resulted in the removal of a large part of the shipbuilding industry to New York, whereas in the earlier days New England, and especially Massachusetts, around Salem, Boston, Newburyport and New Bedford, had enjoyed almost a monopoly of ship construction. The Old Colony was the cradle of the industry but as it grew the movement set in southward down the coast. To-day, the greatest shipbuilding plant in America is established within the Virginia capes,—the Newport News Shipbuilding and Dry Dock Company at Newport News, Va.

New York to a large extent took over the building of packet

ships, and for years the East River teemed with shipyards and shipways, although the keels of some of the fastest and best of the later clippers were laid in Massachusetts shipyards.

The packet ship's cargo was generally made up of high-class freight, and because of the speed of the vessel and the regularity of its sailing, commanded higher freight rates than the ordinary merchantman. In consequence, their owners enjoyed lucrative profit from their operation. They experienced remarkably few accidents, which not only added to their popularity, but augmented their prosperity. Because of their safety they were accorded the most favorable insurance rates and were not at the mercy of a combination of foreign underwriters as American ships of a later period were, up to the time of the Great War, and still are to a somewhat lesser extent.

Among the names of the packets which will always illuminate the pages of American merchant marine history, are the "North America," the "Columbus" and the "England" of the Black Ball line, the "Star of the West," the "Queen of the West," the "Montezuma," the "Harvest Queen," the "Universe," the "Marion," the "Admiral," the "Victory," the "Shenandoah," the "Constellation," and many others.

Some of the later models of packet vessels continued in active service upon the high seas long after the advent of steam liners, even down to the time of the beginning of the war between the states, always giving a good account of themselves.

Some thirty-five years elapsed, after Fulton had sent his little "Clermont" puffing up the Hudson from New York to Albany, and thus demonstrated the practicability of steam as a motive power for ships, before this method of propulsion began to be used on transatlantic vessels. As early as 1812, however, steamers were employed on the Mississippi River, as well as on the Hudson and on Long Island Sound. In 1830, side-wheel steamers began to appear in the coastwise trade of the United States, yet save for the single exploit of the "Savannah" in 1819, the broad Atlantic knew them not.

It remained for the British, rather than the Americans, to begin the development of transatlantic steamers. By so doing, and also by using iron instead of wood for hulls, which they

soon afterwards started to do, they saw an opportunity to regain their prestige upon the high seas, and to compete successfully with their American rivals.

As the abundance of wood suitable for ship timbers had been an advantage to the Americans in their competition with the British, so the development of iron and steel mills in Great Britain proved an advantage to the British when they took to the building of iron hulls and installing steam engines in them.

American builders were reluctant to abandon sail and wood and followed slowly in the path of the British in the matter of introducing steam and iron during the forties. It was while clinging tenaciously to ships of this construction and in their endeavor to hold their own against the inroads of the British steamers that they developed the greatest of all sailing vessels, the Yankee clipper. In their day these marvelous ships, the product of American shipbuilding genius, were the glory of the American merchant marine, and although they were not designed to meet the competition in the transatlantic trade they did serve to maintain American supremacy on the high seas for another fifteen years.

Their low free board, wet decks and battened hatches made them unsuited for popular passenger service. Rather were they useful in heading off the introduction of steamers on the long distance or deep water trades. They were marvels of speed and strength and beautiful in design. Many of them crossed the Atlantic in twelve days, and ten-day voyages,—not achieved by steamers until a quarter of a century afterwards,—are authenticated.

The first of the clippers was the "Rainbow," of 750 tons, launched in 1843, three years after the British had begun to use steam in crossing the Atlantic. In 1846, the "New World," a 1,400-ton clipper, was launched at the McKay shipyard in Boston. At that time she was the largest sailing merchant vessel under the American flag.

The McKay yard became famous for this type of ship and helped to retain for New England a part of the shipbuilding industry which the coming of steam and iron was taking to the Hudson River and Long Island Sound. From its ways

there were launched many of the most celebrated of the clippers, and while they were employed to a limited extent in European trade, their fame was achieved in the long voyages to the Far East and from the Atlantic seaboard of the United States around the Horn to California, in the exciting days of the gold rush.

Among the other famous clippers may be mentioned the "Westward Ho," the "Phantom," the "Sierra Nevada," the "Sea Serpent," the "Young America," the "Sweepstakes," the "Bald Eagle," the "Empress of the Seas," the "Staghound," the "Daniel Webster," the "Staffordshire," the "Washington Irving," the "Anglo-Saxon," the "Ocean Monarch," and the "Star of Empire."

Probably the greatest of all these sailing vessels was the renowned "Dreadnaught," built at Newburyport, part packet, part clipper, which under the command of her no less renowned skipper, Capt. Samuels, in 1860 achieved what will doubtless remain as the record for all time of a sailing vessel crossing the Atlantic in nine days and seventeen hours.

The success of the packet ships and of the clippers lay not only in the superiority of their construction over other vessels, but in the daring of the crews which manned them, and in the intelligence of their commanders. American ship owners required that their masters not only have a knowledge of navigation and seamanship, but of commercial pursuits as well, the nature of exchange, the art of correspondence and sufficient information concerning business affairs to qualify them to represent the interests of their employers to advantage in dealing with merchants abroad.

In her competition with America for mastery upon the high seas, and forced to yield supremacy so long as sails were the motive power, Great Britain turned to steam. As early as 1838, the Admiralty sought proposals from British ship owners for a steam service to America. The result was the building of two British steamers which made successful voyages to New York. They were side-wheelers and able to make about ten knots an hour. Often they were beaten by the packet ships of the American lines, but they served to give great encourage-

ment to their owners and to the British government. Their experience was followed by the building of four others and to these the British government awarded contracts aggregating $425,000 a year for the carrying of mails. This was the first of ship subsidies and laid the foundation of the famous Cunard Company. It was the real beginning of Britannia's great mercantile fleet.

Our own government adopted the British subsidy plan of aiding our merchant marine some six years later, when, in 1845, Congress passed an act authorizing the Postmaster General to enter into contract with owners of American vessels, preferably steamships, for the carrying of United States mails. Under this legislation the first transatlantic mail contract was made with the Ocean Steamship Company for a line between New York and Havre and Bremen. The subvention, however, was only $200,000 a year, somewhat less than one-half of that which Great Britain paid to the Cunard line. It resulted nevertheless in the building of two fine steamers, the "Washington," of 1,640 tons, and the "Hermann," of 1,734 tons. Each was larger than the Cunarders and made better speed. Like their British rivals, however, they were side-wheelers, bark rigged with lofty spars and carried a great spread of canvas which was used when there was a favorable wind. In 1850, two other vessels, the "Franklin" and the "Humboldt," each of 2,184 tons, were added to the line between New York and Havre and Bremen.

Their success, however, was not so marked as was the establishment of the mail-carrying lines to the West Indies, the Isthmus of Panama and the Pacific Coast, even though the subsidies were smaller. A fortunate circumstance gave great advantage and opportunity to these lines. About the time that they were getting under way the cry of "Eureka" went up from the little mill race on the Sacramento River and the joyous shout was heard across the continent. Within a few months the gold rush to California was on. The route overland was long, tedious and hazardous; that by water was quicker, easier and safer, even in sailing vessels around the Horn. The trip by steamer to Panama, thence across the

Isthmus and on up the coast in the ships of the Pacific Mail, afforded the Forty-niners and those who followed them, the best means of reaching the rich diggings in the territory newly acquired from Mexico.

When the "California," the first of the Pacific Mail line of steamers which had sailed from New York late in October, 1848, en route to the Oregon country around the Horn, reached the Pacific side of the Isthmus she found there an excited throng of Argonauts demanding quick passage to the recently discovered gold fields.

The "Panama" and the "Oregon" soon followed the "California" into the Pacific. Excitement and traffic ran high and more and more ships, and bigger ones were added to the two services, one running out of New York to Aspinwall, and now Colon, on the Atlantic side of the Isthmus, and the other from the port of Panama on the Pacific side to San Diego, Monterey and San Francisco. Later there was a combination of the lines under the name of the Pacific Mail and in the ten years that followed no less than twenty-nine vessels were placed in the service. It has been estimated that in that time they carried more than 175,000 passengers and brought back to the east in excess of $200,000,000 of gold. Even this great fleet could not adequately handle the traffic during the decade, and it was supplemented by the clippers which made the voyage around the Horn. It was this fact which helped to prolong the service of these sailing vessels, even against the encroachment of steam, down to the time of the war between the states.

Subsequent to the awarding of the first mail contract to the line to Havre and Bremen and prior to the beginning of the subsidies to the West Indies lines and the Pacific Mail, our government undertook the establishment of another transatlantic mail line from New York to Liverpool. The subsidy offered was $385,000 a year for a new line of steamers making sailings twice a month for eight months of the year and once a month for the remaining four winter months.

This subvention resulted in the establishment of the Collins line which had a brilliant but brief career. Under its stimulus four splendid ships were constructed in New York shipyards,

the "Arctic," the "Atlantic," the "Baltic," and the "Pacific." In their construction government engineers exercised consulting supervision, for the reason that being built for operation under mail subsidy, they were to be available as naval auxiliaries in case of war necessity. The government had specified that they be not less than 2,000 tons, but in each instance the Collins Company exceeded the minimum limit by more than 700 tons. They represented the last word in ship construction, the triumph of American shipwrights, graceful in proportions and built of the strongest and finest materials. The frames were of white oak and live oak, with especially heavy oak keelsons under the boilers and engines. The planking was hard pine, fastened below the water line by copper bolts and above by galvanized iron. There were four decks on each. The engines developed 800 horsepower, which, although small in comparison with modern leviathans, enabled them to make better speed than could be attained by their rivals, the Cunard liners.

The four vessels entered the service at different periods during 1850, and for a time they seemed likely to maintain American supremacy upon the high seas against the rivalry of the British subsidized liners. The Collins line, however, was ill-fated. In the fall of 1854, the "Arctic," the swiftest and finest of the quartet of vessels, collided with a French steamer, the "Vesta," in a dense fog off Cape Race. After giving aid to the wounded ship, the "Arctic" headed for Newfoundland, and although the distance was only sixty miles, she foundered with a loss of more than 300 lives, while the "Vesta" managed to reach St. John's in safety with a loss of only 13 persons. In the winter of 1856, her sister ship, the "Pacific," left Liverpool but never reached New York. Her fate remains unknown, although it is supposed that she collided with an iceberg.

The loss of these two magnificent ships was a severe blow to the Collins line and was followed by a reduction in the amount of the subsidy for carrying the mails, as the result of the adoption of a system which substituted for fixed amounts

of money, payment based upon land and sea postage on letters actually carried.

Sectional feeling, which was soon to burst into civil war flame, was becoming more and more intense. The South through its representatives in Congress expressed the sentiment that the northern steamship owners were getting far greater benefit from the mail subsidies than other parts of the country, and a similar attitude was taken by men from the West, with the result that payments from the public treasury to steamship owners were materially curtailed. The Collins Company, which never paid dividends, but employed its surplus earnings to provide better equipment and improvements in the service, went into bankruptcy. Its fifth steamer, the "Adriatic," which made her first voyage after the loss of the other two Collins liners, was sold to a British company.

The decline of the American merchant marine, already apparent beneath the gathering clouds of civil strife, became decidedly marked as the armies of the North and of the South through four years fought out their issues upon the bloody battlefields of Dixie. Its prestige has never been recovered, although the building of our great fleet during the European war has rehabilitated it to a limited extent.

In 1861, our ocean-going shipping amounted to 2,496,894 tons and 65 per cent. of our exports and imports were carried in American bottoms. Ten years later, in 1871, it was reduced to 1,363,653 tons and only 31 per cent. of our exports and imports were transported under the American flag,—a loss of almost 50 per cent. in each instance. Most of our ships were owned in the North and a majority of them were sailing vessels. Many of them fell easy prey to the Confederate raiders, and even the steamers were not armed for defense. Great Britain profited by our losses, not only in trade but in number of ships. She found it advantageous to purchase at bargain prices during the four years of the war, in excess of three-quarters of a million tons of our ships, and in the exigencies of civil strife they were not replaced by new construction in our American shipyards.

Following the close of the war several attempts were made

to establish transatlantic lines and lines to South America, but only one of them met with any degree of success, and the one exception was not especially noteworthy.

Various causes have been assigned for this decline. Those who have been insistent upon government aid have always contended that failure was due to the fact that Congress steadfastly refused to grant subsidies to American ships, or that the subventions for carrying the mails were inadequate. There were, however, more potent reasons. A revolution had taken place in ship construction; iron and steel had replaced wood. Our iron and steel plants were either in their infancy, or had not been born, and our protective tariff kept out of the American shipyards the necessary plates and shapes with which to construct iron and steel ships. Secondly, Congress rigidly adhered to its refusal to admit foreign built ships to American registry, thus preventing American capital from investing in usable ships of the day and operating them under the American flag.

These two causes combined to induce money to seek other enterprises. Ample opportunity for its use was found in the construction of railroads and in the upbuilding of the interior of the country. The movement westward, begun a quarter of a century before, got into full swing. People turned their attention from foreign trade to the development of domestic trade. The home market rather than the foreign market became their objective. They listened to the call of the West rather than to the call of the waves. There was an empire in the making beyond the Mississippi similar to the one which had been started a generation previously between the Alleghenies and the Father of Waters. "Westward Ho!" became the American slogan rather than "Ship Ahoy!" Meanwhile the maritime nations of Europe, those which must live by the sea, or perish, which depend for their existence upon shipping, took advantage of our greater interest within the broad confines of our own vast domain, and augmented the number of their ships and their shipping.

Although for fifty years there was a steady decline in tonnage, under the American flag, engaged in overseas trade, let

it not be understood that we were without ships during that time. These ships, as has already been pointed out, were employed in coastwise trade which for the purposes of the present showing may also be said to include our vessels on the Great Lakes. This trade has always been reserved exclusively for American ships, with the exception of a short period during the European War, when a limited number of foreign vessels were licensed to ply between American ports.

As far back as 1840, our tonnage in the coastwise trade exceeded our tonnage in overseas commerce by more than 400,000 tons. At that time there were 762,838 tons engaged in foreign trade and 1,176,694 in coastwise trade. It steadily increased while ships in foreign trade were decreasing down to the time of the European War. Throughout the period of our great maritime depression the coastwise trade served to keep our shipyards employed and to maintain our knowledge and skill in the art of building cargo ships. Without it, and naval construction, our shipyards would have been stretches of sandy beach; it kept salt air in our nostrils.

The brief conflict at arms which we had with Spain, in 1898, served to emphasize the weakness of our American merchant marine, but there was failure to profit by the experience of that affair. A fortunate circumstance of a few years previous saved us from extreme humiliation.

A quarter of a century before, an American concern, the International Navigation Company, financed by Philadelphia capitalists, had sought to establish a transatlantic line, but found it necessary to place several of its steamers under the Belgian flag. Some years later the company had opportunity to purchase two magnificent steamers, the "City of Paris" and the "City of New York," building in British yards for the Inman line. As they were about to be placed in service the British Admiralty withdrew the intended subsidy to them, and subsequent negotiations led to their admission to American registry upon condition that the company would build two other similar ships in American yards.

These two ships, christened the "St. Louis" and the "St. Paul," were constructed at the Cramp yard in Philadelphia.

This well equipped and efficiently managed yard, only recently abandoned, was for many years one of the most outstanding shipyards in America, equaling in every respect the great yards on the Clyde. It was there that the first American broadside armor-clad was built. For fifty years or more it continued to launch some of the very best vessels of our navy, as well as excellent merchantmen for the coastwise trade.

The "St. Louis" and the "St. Paul" were of 11,600 tons gross register and exceeded the other liners of British construction by a thousand tons. With their five decks, the most modern water-tight subdivisions, and engines that developed 20,000 horsepower, they were the last word in ship construction. In August, 1896, the "St. Paul" crossed from Southampton to New York in six days and thirty-one minutes, establishing a transatlantic record which it held for many years, until beaten by the German steamer "Kaiser Wilhelm der Grosse," a much larger ship.

The steamers of the International Company enjoyed government benefits which came to them under the Postal Aid Law of 1891, for carrying United States mail to Europe. Of a total annual expenditure of a little less than $1,000,000, for mail transportation, however, they received only slightly more than one-half of the amount. The remainder went to foreign steamships.

At the outset of the Spanish War all four of the vessels mentioned were taken over by the government and equipped as naval auxiliaries along with various other vessels from the "Red D," the Ward, the Pacific Mail, and other coastwise lines. It was these American-built liners, however, which gave notable account of themselves in the operations against the Spanish enemy.

The Spanish-American War was of too brief duration to impress the American people sufficiently with the need of ships. The makeshift had served the purpose sought and the conflict was over before there was a keen realization, generally, of the disadvantageous position in which we would have been placed had our enemy of that day been a stronger power. The lesson which should have been taught went unheeded. So it was that

in the years that intervened between 1898 and the European War, nothing of consequence was done to promote the interests of American shipping.

Various efforts were made from time to time in Congress to provide subsidies for American ships, but each attempt met with failure. The American people were not favorably disposed toward taking money from the public treasury for the purpose of fostering private enterprise, and our statesmanship did not seem to be able to devise a method for the rehabilitation of American shipping by other means.

In 1914, less than 10 per cent. of our foreign trade was carried in American bottoms, and there were years when it had been still less.

Early in his first administration President Wilson strongly urged upon Congress the desirability of shipping legislation. Somewhat reluctantly steps were taken which admitted to American registry a little less than 550,000 tons of foreign-built ships. This action, however, did not increase American shipbuilding, for construction in American yards decreased in about the same proportion that foreign-built ships were acquired.

Credit should be given to the late Bernard N. Baker, well-known ship owner and operator of Baltimore, for originating and forcefully presenting the plan which resulted in the creation by Congress of the United States Shipping Board, through whose activities during the period of our participation in the Great War and subsequent thereto (but in consequence thereof), nearly 9,500,000 tons of ships were added to the American merchant marine.

Although drafted as a peace measure to advance the interests of our merchant marine, the Shipping Board, almost from the day of its organization, became an instrumentality of war upon which devolved one of the most important functions of bringing the great conflict to a successful conclusion. Its declared purpose was to encourage, develop and create a naval auxiliary and a merchant marine to meet the requirements of the commerce of the United States.

It was plainly not the intent of Congress that the Shipping

Board should engage in the operation of ships. Whatever sentiment there may have been among the legislators for a program of government ownership and operation of a merchant marine, was expressly forestalled by a provision in the law to the effect that ships acquired by the Board, by construction or otherwise, should not be operated by any corporation in which the United States was a stockholder, unless it should be found impossible to get private capital to purchase or charter them under terms and conditions approved by the Board.

The exigencies of war, however, obliged the Board to ignore that provision at the outset. Events showed that the lawmakers had acted wiser than they knew in giving the Board power to form one or more corporations for the purchase, construction, equipment, lease, charter, maintenance and operation of merchant vessels.

The Board had scarce begun to function when war was declared against Germany, on April 6, 1917, and ten days later, the Board exercised the power stated, by organizing the Emergency Fleet Corporation with a capital stock of $50,000,000, all of which was subscribed for by the Shipping Board, with the exception of the necessary qualifying shares. The powers under which the activities of the Shipping Board and the Fleet Corporation were carried on throughout the war were not those contemplated in the Shipping Act. For the purpose of prosecuting the war Congress clothed the President with extraordinary and sweeping authority, and this authority the President, by executive orders, delegated to the Shipping Board and to the Fleet Corporation, so that both became his direct agents. In the performance of the stupendous task laid upon it, the Fleet Corporation expended more than three billions of dollars, an amount doubtless more than three times as great as would have been required in peace times to build the same amount of tonnage that it produced.

At its inception, the war reduced the amount of world tonnage by some 7,000,000 tons,—6,000,000 tons under the German flag and 1,000,000 tons under the Austrian flag—by internment in home and neutral ports where ships would be safe from the superior sea power of Great Britain. Heavy addi-

tional shrinkage was caused by the German submarine campaign, yet the need for ships was greater than ever before in the history of the world. Freight rates soared, and the price of tonnage advanced to figures never dreamed of, yet Europe was willing to buy of us. In order to retain our limited tonnage for our own purposes, the President, at the request of the Shipping Board, which had been given control over American ships and shipping, declared an embargo on the transfer of American ships from American registry.

Despite the imperative demands for ships to carry supplies for the troops which we were preparing to send to France, to transport farm products with which to feed a large part of the population of Europe, as well as for the importation of raw materials for our manufactures, there was not an idle shipway in any yard in the United States where the Emergency Fleet Corporation, when it began to function, could go and place an order for the building of a vessel.

The seizure of German and Austrian interned vessels gave us approximately 700,000 gross tons of ships. They included many fine hulls of the passenger-cargo type. The most notable of these was the "Vaterland," rechristened the "Leviathan," at the time one of the two largest ships in the world. She transported nearly 100,000 troops to France, and now, reconditioned, is the pride of the American merchant marine. Practically all of them had to be overhauled before they were serviceable, for their German crews had sought to make them useless to their new enemy. All of them, however, were repaired and now constitute an important part of our overseas fleet.

Six months after the Emergency Fleet Corporation was formed it had assumed supervision of the building of 1,118 ships of different types in 116 yards. During the war its organization was twice as large as the United States Steel Corporation and its operating expenses were equal to the combined expenses of the Pennsylvania and the Santa Fe railroads. When the shipyard owners found that they could not control either their supply of labor or material it became necessary for the Fleet Corporation to step in and manage the yards. Entire

yards had to be built, at an expense so great that it could not be defrayed by private enterprise. In the end the Fleet Corporation had to build the yards with government money and to act as their banker.

The total program of construction originally was as follows:

431 requisitioned steel ships, of 3,056,008 deadweight tons,
1,741 contract steel ships of 11,914,670 deadweight tons,
1,017 contract wood ships of 3,052,200 deadweight tons,
50 contract composite ships of 175,000 deadweight tons,
43 contract concrete ships of 302,000 deadweight tons,

A total of 3,282 ships of 18,499,878 deadweight tons.

Not all of these ships were completed and added to our merchant marine, as many contracts were canceled following the armistice. Because of the necessity of building many new yards the peak of production was not reached until 1919, when without overtime or the exertion of the high pressure which prevailed during the war the Fleet Corporation built and delivered 1,181 ships amounting to 6,379,823 tons, an average of four ships a day.

The fact should be borne in mind that the construction done under the Fleet Corporation was primarily to meet a war emergency; the use of its ships for commerce after the return of peace was a secondary consideration. Hence, in many instances they were not immediately suitable for various trade routes.

War conditions produced an entirely new character of vessel, —the fabricated ship. The fabrication principles had been used successfully in the erection of bridges and office buildings. Prior to that time ships had always been built in the shipyard, from the keel up. Under the new method, instead of building ships, they were manufactured, as automobiles, locomotives, and watches are manufactured, according to one pattern. This made it possible to roll, bend and punch frames and shapes in steel mills far inland, transport them to the yards on the coast and there rivet them together into finished hulls. Many of these ships were fabricated in the bridge shops of the country. The amount of fabrication varied from 60 per cent.

of the work on a ship, at first, up to 85 per cent. later in the development of the principle. Most of the ships so constructed are now a part of the American merchant marine.

Four yards for the assembling of fabricated ships were established after our declaration of war,—the Hog Island yard at Philadelphia, the Submarine Boat Yard at Newark Bay, the Merchant Shipbuilding Yard at Bristol, Pa., and the Carolina Shipbuilding Yard at Wilmington, N. C. They had a total of ninety-four ways, of which fifty were at Hog Island and twenty-eight at Newark Bay. Their combined contracts called for approximately one-fourth of the total steel ship construction of the Fleet Corporation. In full operation they could produce more tonnage in a year than was ever produced by all the shipyards in any country, prior to 1918.

The Submarine yard was only a smaller edition of the Hog Island yard and built 5,000-ton vessels. It accomplished the remarkable feat of laying its first keel three months and six days after contract had been signed for the building of the yard, and launching its first vessel in eight months and fifteen days, a world's record in shipbuilding.

According to the most recent report of the United States Shipping Board that body has acquired throughout its activity a little in excess of 14,700,000 deadweight tons of shipping, from all sources including construction, vessels transferred from other government departments, vessels purchased and those seized from the enemy. This list includes all types of vessels, both of steel and wood, passengers, cargo ships, sailing ships, colliers, tankers, barges and tugs. At the present time it has documented with the Commissioner of Navigation approximately 4,475,000 gross tons, represented by 864 steel vessels. The same authority gives the total American tonnage of vessels of 100 gross tons or over, as 14,583,000, of which a little less than 1,000,000 tons is represented in sailing vessels, while the total of those vessels in excess of 1,000 tons is 10,950,000.

Of the total of our seagoing tonnage, 3,033,000 is laid up, and of this amount more than 2,500,000 tons is represented by vessels owned by the United States Shipping Board, while

the remainder is privately owned. This is an appalling percentage of government-owned vessels not in active service. It alone is nearly seven times as much as Great Britain has laid up out of her 22,000,000 tons. Last year the expense to our government of inactive vessels of the Shipping Board was $3,843,000, while the total loss sustained by the Shipping Board in its operation of vessels was $19,606,000. Only the operation of its tankers and its tugs made a profit,—the latter merely nominal. This showing clearly proves that the government should get out of the shipping business, so far as ownership and operation are concerned, as soon as possible.

The Board is also now expending $25,000,000 in the installation of Diesel engines in its ships, which is another advanced step in the equipment of our merchant marine. The chief difference between the Diesel motor and the internal combustion engine of familiar every-day use lies in the fact that a Diesel engine has no sparking mechanism to ignite the fuel, this function being performed by the heat due to compression of the air necessary for combustion. The fuel is burned rather than exploded, as with gasoline vapor.

A word should be said about this engine as it promises to become the motive power of many future vessels. It is the invention of Dr. Rudolf Diesel, born in Paris, of German parents. His first engine was constructed in 1893, but it was not until his third attempt, in 1897, that he produced a successful and reliable engine.

The introduction of the marine Diesel engines in America was associated with the development of the submarine by the Electric Boat Company, when designing successful submarines for the United States, England, Holland, Japan and other foreign navies. The use of gasoline engines was a constant source of danger. It was realized that if a suitable type of internal combustion engine using fuel oil could be perfected the major problem of submarine navigation would be solved. The first marine Diesel engines to be installed in America were built by the Electric Boat Company and placed in the U. S. Submarines E-1 and E-2, in 1910.

The company then organized the New London Ship and

Engine Company, which was the first organization in America to devote its entire time to the development of the Diesel engine under license from the German company. Later, it installed Diesels, in yachts, navy cutters and tow boats, and, in 1914, in submarine tenders, passenger boats and fishing vessels. Since these pioneer installations, Diesels have been adopted in America for many types of vessels. The most powerful Diesel in this country is the 3,860 horsepower two cycle, double-acting engine now being installed in the "S.S. Wilcox," a Shipping Board vessel of 9,500 tons.

The last five years have shown a tremendous increase in motorship construction. It will be noticed from the following table that the last report published by Lloyds in 1927 indicates that there is more motor tonnage now under construction than steam:

	Steam Tonnage	*Motor Tonnage*	*Per Cent. of Motor to Steam Tonnage*
December, 1922	2,640,572	288,057	10.9
December, 1923	1,753,579	694,057	35.5
December, 1924	1,530,884	923,738	60.
December, 1925	1,041,119	1,007,381	97.7
December, 1926	1,005,224	905,675	90.
June, 1927.........	1,366,890	1,459,595	106.

Lloyds' report of July 5, 1927, indicates that there are now in actual service 508 motorships of more than 2,000 tons, with a total displacement of 3,105,038 gross tons.

The United States now has documented approximately 4,475,000 tons of ships, represented by 864 steel vessels. It would seem that the time has come when government ownership should cease and our entire maritime industry be restored to private enterprise.

In this connection it should be pointed out that the day has passed when one or two ships, or a tramp, can be successfully operated in competition with the ships of other nations. Great Britain's shipping is in the hands of a few large corporations. It has become mandatory that we develop real leaders in the

shipping world to operate and manage companies, with offices in all parts of the world. Such a program necessarily calls for a high overhead, and unless we think in this direction along broad lines and formulate our plans on a scale as large as our competitors, our merchant marine will be handicapped and ineffective.

It would seem that the great railroad organizations are the best equipped to solve our problem; they have the machinery required, and only expansion would be necessary. Theirs is the business of transporting passengers and freight. Take the trunk lines that reach our salt water ports. If these roads and others now contemplating consolidation would join, with the approval of the Interstate Commerce Commission and the Shipping Board, with the shipping companies engaged in overseas trade, great progress would be made. The long haul makes for economy in handling and consequently greater profit.

If our great railroads now so well managed, but confined to the transportation of foreign and domestic freight between the seaboards of the country, were to extend their facilities by operating a fleet of ships, freight could be moved to the markets of the world under a single bill of lading, and the success of our merchant fleet would be assured.

It is not an untried experiment. The Soo Line railroad, controlled by the Canadian Pacific, now accepts freight for any port in the world and moves it by its own carriers to its destination, wherever it may be. It is able to do this through its own passenger and freight shipping company,—one of the largest afloat. The through bill of lading which it gives to the shipper may be presented at the bank and receive credit the same day.

Many of our railroads have agents in foreign countries. These agents arrange for freight to be shipped over their lines in America, but they have only the land part of the haul.

The operation of a merchant fleet by a railroad would materially reduce the cost of operation. Likewise, the expense incident to the procuring of freight and passengers for ships would be reduced to a minimum, compared with present

methods which duplicate each other. Under a unified system of international transportation, managed by the railroads, it would be possible for an inland station agent to quote passenger and freight rates to any country. He would know the sailings of all passenger and freight vessels, and this information would soon stimulate a lasting interest in overseas travel and trade.

There is a great difference in the cost of constructing a ship in the United States, compared with the cost of construction in Great Britain and Germany, because our wages are higher. This differential in cost also applies to the operation of our ships. The United States Steel Corporation, the Standard Oil Company of New Jersey, and other large operators of tankers have been able to run their fleets profitably under the American flag by efficient methods of handling their crews, and particularly by quick turn around at ports and other effective methods which have tended further to cut this differential.

The objection to a ship subsidy where the government pays the interest on the capital invested, is that it breeds inefficiency and kills initiative. There are other methods whereby the government can give aid besides in the form of a direct gift, which is all that a subsidy really is. Subventions in the form of payment for training deck and engineer officers, and for carrying regular mails and parcel post, would be more in keeping with the thought of enduring success.

In addition, money secured by first mortgage and loan by the government at reasonable rates of interest could be used to encourage the building of fast passenger and cargo ships.

Meanwhile the ships which the government now owns should be sold at once and at exceptionally low prices so that they may go into immediate service. Otherwise within a few years they will be obsolete. The new high speed freighter has become the ideal ship. Slow vessels constructed during the war cannot compete with the faster ships, any more than the inferior sailing vessels of Great Britain could compete with the American packets of a century ago. The longer the government retains them, the more difficult it will be to sell them.

If sold now, at a figure low enough, the purchaser can make

a fair showing, because his interest charges on capital investment will be reduced to the minimum. This will allow a margin for competition with more modern ships. The main objective, however, is to get them into service and in the hands of private companies, regardless of the price, before they become worthless.

We cannot have a successful merchant marine unless it is efficiently managed and receiving yearly revenue that will pay fair returns on the capital invested.

When we have favorable financial statements, American shipping securities will be purchased by our bankers and sold to the investing public. There cannot be favorable balance sheets in intercoastal or overseas trade with the present uncertain methods of establishing and maintaining rates.

It is a remarkable fact that there is to-day less progress being made toward improving the efficiency of ship operation than in any other branch of industry. This is true of shipping in all countries. Where there are hundreds of efficiency expert engineering organizations in nearly every line of manufacturing and merchandising, there is not one devoted to the study of cost-reduction in ship operation.

IV

FOREIGN TRADE

By Julius Klein

Director, Bureau of Foreign and Domestic Commerce

COMMODORE VANDERBILT, the founder of the great business organization built up under that family name during the nineteenth century, was once asked why he diverted his interests from the merchant marine to railroad development at the time of his early activities in establishing the New York Central lines. "That's simple," he replied, "six per cent. is twice as good as three per cent."

And indeed this statement goes far toward explaining the whole relationship of our overseas interest to the general economic development of the country during the past century. Whenever it became economically advantageous to do so, our foreign trade interests, which absorbed a relatively large proportion of our total commercial life during the early decades of the Republic, were diverted to more lucrative fields at home. And this in spite of intermittent emotional patrioteering, which seems always to have been an accessory to our foreign trade thinking. The calm, cold business aspects of the situation have naturally been the real determinants of the trend of our foreign trading regardless of all the flag-waving, thunderous after-dinner oratory, "pointing-with-pride," and so forth.

The records of the century may be used as an indication of the moderate but helpful part which foreign trade has played as a stabilizer of our whole business development. A careful scrutiny of the variations of our exports reveals their service as an outlet in time of domestic stress and as a general stabilizer of industrial life as a whole during more recent decades when

fabricated wares have become increasingly conspicuous in our commerce in general.

In spite of the fervid publicity so frequently given to the subject of late, it has, of course, played a relatively moderate part in our commerce as a whole, but although it does not bulk large in the economic machinery of the nation its function as a pendulum, so to speak, has been invaluable and on more than one occasion since 1827 has played a vital part in keeping the business life of the nation from real distress and modifying the seriousness of various crucial periods.

The value of our overseas outlets during such crises as the panic of 1837, the depressive period of 1873 and after, and the crash of 1907, will be fully developed as we proceed with the record. In each case, foreign commerce provided a most helpful corrective of the domestic situation which, in part, at least, moderated the disasters of the domestic crash.

Ordinarily a period of warfare is regarded as a real disaster to the economic status of the participants and such indeed it is so far as the destruction of men and materials is concerned. It must be noted, however, that among the compensating features, which, at least to a moderate extent, served to contribute to the more favorable side of the balance, is the sharp stimulation of productive energies made necessary to strengthen the national resources during the particular struggle. As a result we have the industrial expansion which has been so strikingly evident during each of the periods of warfare in the past century of our history. There was a notable expansion of our industries in the course of the rallying of national strength and resources during the Mexican War, Civil War, Spanish-American War, and finally and most dramatically of all, the great struggle of 1914-18. Consequently, the industries of the country were faced after each of these crises with the grave problem of disposing of surplus and of occupying the excessive productive capacity developed during the preceding conflict.

In these emergencies the overseas markets have been resorted to with rapidly increasing energy and, on the whole, with material benefit. Naturally, however, much of this immediate post-war expansion was abnormal and there came the

usual recession. But in general during the decade that followed each war, there was a gradual readjustment upward with the natural result that foreign trade assumed a steadily larger part in our whole commercial development.

Finally, it is interesting to note the position of foreign trade as a reflex of the general westward movement of our national economy. The opening years of the century under discussion were marked by an intensive concentration of the forces of the nation upon the vast problem of introducing the equipments of civilization into the Mississippi Valley. For a time, therefore, there was a lull in foreign trade development. But as the new western agricultural enterprises came into bearing the trend of our exports of farm products took a sharp upward turn because of the availability of surpluses not needed for domestic consumption. Then after the Civil War, as the transportation facilities—the highway and railroad network, and the waterways—were more intensively exploited and developed, the new communities of the vast western lands absorbed a greater proportion of the available produce. In the course of time the new industries developed in the recently established communities soon caught up with domestic consumption and once more we have a new drive on foreign markets.

In other words, each successive wave of our westward economic evolution has had a corresponding reflex in foreign trade activity; the story of our overseas commerce thereafter becomes an interesting indicator of the general trend of our economic evolution.

Since our first official trade statistics of any consequence became available in 1821 it might be interesting to make some general comparisons between our status then and now with reference to the subject at hand. During the intervening period our exports have multiplied one hundred and eleven times and our imports have increased sixty-eight-fold. Of course, a substantial deduction would have to be made for the considerable deterioration of the purchasing power of the dollar in that time, but even so the figures give ample indication of the impressive growth of this branch of the nation's business. In 1821 the exports were $4.53 per capita as compared with

$41.29 to-day, while the per capita imports rose during the same period from $6.49 to $36.08. In 1821 all of the foreign commerce of the United States was carried on by sea, whereas to-day a very substantial portion, nearly 12 per cent., moves across our two land frontiers by rail. At the beginning of the century American vessels carried nearly 93 per cent. of our total water-borne traffic, whereas to-day the proportion is about 35 per cent.

The geographic alterations in our commerce since the opening of the century bring out picturesquely the changes that have taken place in the commercial geography of the world since that time.[1] For example, what we now know as European Turkey was then indicated as "Moldavia, Walachia, Bulgaria, Servia, Bosnia, Romelia, Morea, Albania, Dalmatia, and part of Croatia," and Asiatic Turkey as "Anatolia, Caramania, Roum, Syria (including Palestine, or the Holy Land), Diarbec or Algezira, Irak, Arabia, Curdistan, Armenia or Turcomania, Georgia, Imeritia, Mingrelia, and Circassia," to use the boundaries and spellings of that day; colonization of the Australian continent (then called New Holland) had scarcely begun; and much of Africa was still at its "darkest"—to mention only three of the regions where great changes have taken place during the century.

It is, therefore, difficult to make any accurate comparisons save perhaps by continents as to the general trend of our commerce. Nevertheless, it is interesting to note that at the beginning of the period under review England was, as she still is, our leading market by a wide margin. In 1821 she took nearly forty-two million dollars' worth of American exports as compared with the second market, Cuba, which absorbed a little more than eleven million dollars in American commodities, followed closely by France, with something more than ten millions. Thereafter came China ($7,400,000), Holland ($5,600,000), Haiti ($4,500,000), and the Danish West Indies ($3,800,000).

At the opening of the century, England took nearly 38 per

[1] An interesting article on "One Hundred Years of American Foreign Trade" appeared in "Commerce Reports" of March 16, 1921.

cent. of our total exports, whereas the Cuban share indicated above was but little more than 7 per cent.

On the side of imports, England supplied us with slightly more than 37 per cent. of the total and Cuba about ten per cent.

The Chinese trade is especially interesting because of the difficulties encountered in the long sea voyage. The exports were of varied type, including miscellaneous manufactured commodities and such oddities as medicinal plants (notably ginseng), and even ice, which was shipped in considerable quantities from New England around the Horn.

By way of comparison with the present situation, it may be noted that England takes about 20 per cent. of our exports to-day as contrasted with more than 37 per cent. a little over a century ago, while Cuba's share of exports has dwindled to a little more than 3 per cent. and China's to 2 per cent.

Turning to commodities, it is natural in view of the lack of any large scale cloth industry in the young republic and the prime need of substantial and ample clothing for its rigorous climate and rough pioneer life to find that at the opening of the century under discussion the leading item of import was piece goods of various types, including linen, hemp, cotton goods, silk, and woolens, which together made up over 35 per cent. of our total purchases, valued at more than twenty-two million dollars. Other items included coffee (about $4,500,000), wines and spirits ($3,600,000), sugar ($3,500,000), iron and steel manufactures ($3,200,000), and molasses ($1,700,000). However, only two of these items continue to occupy upper positions in the totals of our imports, namely sugar and coffee. To-day the outstanding commodities among our purchases from overseas are rubber, raw silk, coffee, sugar, paper, petroleum, and furs.

With reference to exports, raw cotton was first in 1821, just as it is to-day; but though the value of our exports of that commodity has increased forty-three times during this period it comprised less than 18 per cent. of our total exports in 1927, as against about 46 per cent. in 1821. In the latter year the other commodities of major export significance were tobacco, flour, rice, lumber, pork products, and fish. In contrast with

this list, the six leading commodities to-day, in addition to cotton, include petroleum and its products, machinery, automobiles, wheat and flour, and packing house products. In other words, three of the six leaders to-day were prominent a century ago, but the other three are clearly indicative of the newer industrial development in the country—the enormous expansion of the oil industry, the development of automotive production, and the vast growth of manufacturing of agricultural implements, electrical apparatus, and other items classed under the general heading of machinery.

Let us examine in some further detail the general trends of the foreign trade growth during the period under review. The late eighteen-twenties found our foreign commerce at the end of a period of dullness which had begun about 1818. In fact, by 1830 the total exports were actually less than they were some twelve years previous. This was due in part to the general decline of prices but there was also a falling off in volume.

Even more conspicuous was the falling off of the import trade, which had dwindled to such an extent that for several years there was actually an excess of exports over imports,—a phenomenon quite striking at this period since it was not until 1876-80 that the trade balance, when calculated on five-year averages, showed a normal "favorable" or export excess. Imports from almost all of the important countries of Europe fell off materially, as did also those from the West Indies.[2] There was a general stagnation of trade in both directions during this period up to 1830. Until 1835 imports ran below nineteen million dollars annually, except in one year. It is worthy of note also that not less than one-third of the imports were re-exported, so this substantial portion of the trade was important only insofar as it provided traffic for the merchant marine.

In general the decade 1825-35 showed a relapse from the abnormally high export figures which immediately followed

[2] The various writings of such nationally known authorities as G. G. Huebner, Walter W. Jennings, and Clive Day, are especially valuable on this period; particularly useful are the chapters by Huebner in "The History of Domestic and Foreign Commerce of the United States," edited by E. R. Johnson (two volumes, Washington, D. C., 1915).

the termination of the war with England in 1815. As was indicated above, each conflict during this period was followed by an upward trend in our export activities and there came the inevitable sag with the major losses in the exports to England and the West Indies. Curtailments were evident in all commodities, with two exceptions, namely cotton and manufactured goods. Trade was materially curtailed in such important items as fish, lumber, naval stores, tobacco, corn, and wheat. Cotton growing had a very substantial increase during this period so that a large portion, perhaps 40 per cent. of it, was grown in the relatively newer plantations of Tennessee and the lower Mississippi Valley. These virgin lands contributed largely to the impressive increase of cotton exports from eighty-seven million pounds in 1819 to two hundred and ninety-eight million pounds in 1830. The advance in manufactured exports, as pointed out by Huebner, was due primarily to the growth of the cotton, textile, shoe, soap, candle, hat, wood, and iron industries.

The explanations for the foreign trade decline, as given in Pitkin's classic study and elaborated by Huebner, were first of all, of course, the general repercussions from the panic of 1818-19 and the rapid development of domestic commerce which absorbed an increasingly large proportion of the slender resources of the young republic. New England was gradually turning from the old policy of free trade to one of protection for the newly stimulated industries and her place as a leader of the overseas commercial interests of the country was gradually being taken by the South, with its increasingly heavy shipments of cotton, tobacco, and naval stores. The growth of home industries during this period was extraordinary, and resulted in a tremendously increased demand for raw materials which hitherto had only found a profitable market beyond the seas. These industries rose in part as the result of the successive protective tariff acts of 1818, 1819, 1824, and 1828.

At the same time there were tariff acts, corn laws, and other measures on the part of European countries, which curtailed the outlets for American exports, particularly of agricultural products. The first stages of the present-day British "Im-

perial Preference" policy favoring raw materials from the various units of the Empire were inaugurated at this time and as a result every effort was made to bring in cotton from India and the West Indies. On the whole, the period from 1818 to 1830 was one of downward readjustment after the usual post-war inflation, coupled with the diversion of trade currents to the newly developed domestic industries.

There was a slight improvement in trade from 1831 to 1835 but the first definite signs of recovery did not appear until the latter year, when, for the first time, the record export totals of 1807 were surpassed.

The net result was a much more satisfactory foundation for our international business and as a result there was a steady growth in exports from 1835 to 1860 until the record mark of $316,000,000 was reached in the latter year. The trade balance throughout this period was normally unfavorable, that is, with a heavy excess of imports due partly to the invisible favorable items in the trade balance, notably shipping services rendered by the famous clipper ships, and also to the increasing needs of the rapidly growing population for finished manufactures from European centers.

In connection with shipping, in spite of the growth of the American Merchant Marine, there was a gradual decline in the proportion of total exports being carried in our own vessels, the percentage sinking slowly from 86.6 per cent. in 1830 to 70 per cent. in 1860. In imports our loss of the carrying traffic was more rapid; American vessels carried over 94 per cent. of our total incoming shipments in 1830 and only 63 per cent. in 1860. Even before the widespread introduction of European steel shipping, therefore, it was evident that the American Merchant Marine was losing its predominant position as a carrier of our commerce.

A conspicuous feature in our export trade was the gradually increasing importance of New Orleans. In 1833 for the first time Louisiana passed New York as the leading export state, having in that year a total value of outgoing shipments of more than $16,000,000. She retained this predomi-

nance down to the Civil War, a factor which was explained, of course, not simply by the enormous growth of cotton exports, but also by the development of southbound river traffic from the newly opened lands of the West.

The increasing prominence of western and northern agricultural commodities generally is an outstanding feature of this period; for example, the annual average of butter exports had been a little more than 900,000 pounds during the period 1810-1840, but for the decade 1841-1850 the yearly average was nearly 3,400,000 pounds. In other words, this period represented the sudden bursting into productivity of all of the newly opened areas west of the Alleghenies, and with the total inadequacy of domestic demand to absorb the enormously increased supplies, there was an inevitable effort for the exploitation of overseas markets.

With the heavy concentration of the energies of the South upon the cotton-growing industry, there was naturally a sharply increasing demand on the part of its population for practically all commodities outside of a few limited foodstuffs. The growth of the British textile industry supplied a valuable market for the South's great staple, and as a result all of the ports on the Gulf and our South Atlantic Seaboard became great centers for foreign commerce.

The penetration of the new lands which were contributing so heavily to this export traffic went on apace, not simply by the construction of highways, but also by the opening up of river and canal traffic.

The annual average of total exports rose from $69,000,000 during 1821-1830 to $123,000,000 during 1841-1850; meanwhile the import averages climbed during the same period from $73,000,000 to $121,000,000.

It is interesting to note the shifts in geographic distribution of our overseas traffic. As indicated above, Europe was, of course, the most important consumer; in fact, her share of our total exports increased from 65 per cent. in 1821 to 75 per cent. in 1860. The sharpest decline during that period was in the case of Southern North America, including the West Indies,

whose share fell from 22 per cent. to less than 9 per cent. during that time. The proportion of commerce to South America and Asia remained about stationary during that period.

In contrast with the export trade which was pretty generally scattered over a number of states along the Seaboard, the import traffic was concentrated in a few ports in the North Atlantic, New York taking nearly two-thirds of the total and acting as the gateway for most of the inland and even southern import trade.

After the boom period of foreign trade activity from 1831 to 1837, there were several years of more or less uncertainty. The panic of 1837 seriously damaged domestic demand and resulted in a temporary encouragement of overseas interest, but the general irregularity of business as a whole left scanty resources for any intensive permanent campaigning beyond the seas. Values declined somewhat, partly because of widespread industrial distress in different parts of Europe during this decade and also because of a tendency toward overproduction throughout the West and South.

With the close of the Mexican War in 1847, however, there came an immediate burst of commercial activity which rolled on with increasing momentum until the opening of the Civil War. The discoveries of gold in California in 1848, in Australia in 1851 and Colorado in 1859 contributed to this movement and inspired the construction of the Panama Railroad which, with the exploitation of the Nicaragua Route, led to a marked increase in trans-Isthmian trade, not only with California and Australia, but also with the Pacific Seaboard and Latin America.

At the outbreak of the Civil War American export trade had attained a strong position, exceeding $333,000,000 in value, or more than six times as much as it was in 1821. Meanwhile, imports had climbed from $54,000,000 to $353,000,000. Deep-sea vessels had in the meantime risen in tonnage from less than two million to more than seventeen million; the American Merchant Fleet had grown from 854,000 to 2,400,000 tons. As Huebner very well sums up this period, it was one of "prosperous growth during which the general char-

acter of foreign commerce was in many respects considerably altered." First of all there was a permanent relative decline in the volume of raw exports. The relative importance of tobacco as an export was permanently lost and the same was true of fish and naval stores to a large extent, as well as of indigo, fur and especially rice, all of which had long been featured in export figures but waned in importance during the eighteen-sixties. Several of these disappeared because the South was centering upon cotton and others because the North was turning from fish and the fur trade to agriculture and manufacturing, but the outstanding feature of our foreign trade during this period was that, substantial though its totals became, it was an increasingly minor adjunct to the enormous expansion of domestic trade.

No review of the foreign trade of the nation just before the Civil War would be complete without some reference to the shipping situation. The period 1840-60 was the high water mark in American merchant marine history so far as its relative position in the world's ocean navigation is concerned. Our tonnage was equal to that of the British; we carried substantially more than three-fourths of our total trade in our own shipping and, as a matter of fact, because of the greater speed and efficiency of the American clipper ship, the first example of which was produced in 1845, the traffic handled in these vessels was much more valuable than that entrusted to their rivals. The clipper reduced the sailing time from Canton to New York by about three weeks. There was even an instance or two of trans-Atlantic crossings in nine days.

These speed ships labored under certain difficulties, however; first, as to the limited amount of cargo space available, and secondly, because of excessive tonnage duties levied in many foreign ports upon ships of their peculiar construction. Nevertheless, tonnage production went on apace so that the total under the American flag in 1860 was 2,500,000 tons as compared with only 600,000 in 1830. The high point in construction was reached in 1855 when more than two thousand such vessels were sent down the ways.

But as Van Metre points out, the very quality of these craft

was in part responsible for the decline of our merchant marine. Their efficiency made American ship-owners overconfident as to the superiority of sailing vessels over steamships. "An American inventor built the first successful steamboat, and an American ship-owner was the first to cross the ocean in a steamship, but it was the British that recognized the commercial possibilities of ocean steam navigation and developed the ocean steamship service." In the late eighteen-thirties various steamship companies were organized largely under British control or ownership, which soon cut the trans-Atlantic sailing time down to twelve or fifteen days as compared with the sailing-vessel average of about twice that time.

With regard to the commodity aspects of our trade, as was indicated above, the leading export item throughout this period was cotton, which made up practically half of the total. The South also contributed very substantially in two other products, namely, tobacco and rice, though these declined in relative position during the closing years of the prewar period. On the whole, the South was distinctly the great export center of the country, though its position with reference to imports was much less conspicuous since New York handled about two-thirds of the incoming traffic after 1850. Boston was the second import center, but she handled considerably less than one-third that of New York.

The Civil War inaugurated a period of temporary lull or, at most, more moderate advance so far as exports were concerned. This was due, of course, to the serious embarrassments of the leading southern agricultural export items, notably cotton and tobacco, as well as the war-time preoccupations of many northern industries and the general destruction of shipping by southern raiders, especially the "Alabama," and the elimination of American sailing craft by the rapid expansion of British steam tonnage. In 1860 more than 66 per cent. of our total exports and imports moved in American ships, but ten years later the proportion was down to about 35 per cent. Thereafter the decline continued until the Great War, but the maximum rate of diminution was during the decade of the Civil War.

This combination of circumstances accounts in part for the

fact that our domestic exports rose only from $316,000,000 to about $377,000,000 during 1860-70; and with appropriate deductions for price advance this meant an actual decline in the total volume of goods moved. Imports suffered even more drastically, having fallen during this period from $534,000,000 to $436,000,000, with an even greater proportionate decline in volume.

The crisis of 1873 naturally contributed further to the impairment of overseas traffic through the sharp curtailment of credit and the temporary embarrassment of newly established industries which had made some headway after the Civil War.

From 1875 onward, however, American export trade launched into a largely spectacular advance. In fact, the beginnings of this upward trend took shape in the further necessity for foreign markets to absorb surpluses of war-born industries on the one hand and to compensate for such domestic distress as was generated during the recent crisis on the other. Except for a momentary lull during 1886-90, the last three decades of the century showed an advance in export values from about half a billion dollars a year during 1871-75 to more than $1,157,000,000 annually during 1896-1900. It should be noted, furthermore, that there was a general downward trend of prices during the last quarter of the century and consequently the actual growth of the volume of commerce was even greater than the above figures would indicate.

So far as the general items of export are concerned, nearly two-thirds of the outward shipments were made up of only seven items, all of them raw or partly processed staples, with cotton normally leading the list, though it was displaced in one or two years by breadstuffs when there was an extraordinary shortage in other producing lands or when serious famine conditions developed in parts of Europe. Furthermore, an increasing prominence was given to the meat trade and even to dairy products—a reflex of the growing advancement of agricultural technique and diversification throughout the West.

In spite of the prominence of these items, however, the relative importance of farm products showed signs of diminution. They had supplied over 82 per cent. of the total exports in

1860, but by the close of the century were providing less than half. Mineral and forest products were now increasingly conspicuous and manufactures were likewise coming forward. This transformation is best indicated by the fact that whereas our foodstuffs exports rose only from $460,000,000 in 1880 to $545,000,000 in 1900, the value of manufactured exports grew during the same period from $121,000,000 to $484,000,000. So far as proportions are concerned the situation is even more dramatic; the share supplied by foodstuffs dwindled during those two decades from 55 to 39 per cent., whereas finished manufactures advanced from 14 to 35 per cent. of the total of domestic exports.

An interesting feature of this new era is the first appearance of what have been designated as specialties in our manufactured exports—those contrivances, produced largely by New England factories at that time, which have been increasingly conspicuous in our foreign trade. For example, sewing machines appeared in our export figures for the first time immediately after the Civil War and by 1872 were averaging $2,500,000 in value annually. Similarly, watches and clocks were being shipped with an average of over a million during 1875-80. In general, the manufactures of iron and steel, including stoves, wire, hardware, nails, locomotives, etc., jumped in annual value from about ten million dollars during the years 1866-70 to about sixteen million dollars during 1871-80.

The fuel possibilities of petroleum were not fully understood until after the Civil War. But during and after the war the importance of this valuable fuel commodity rose rapidly in our export trade, increasing from about twenty-one million dollars in 1868 to an annual average of more than fifty millions in the late eighties. It was well on its way toward the prominence which it has achieved in later years, having now taken its place as our second export, outranked only by raw cotton.

The value of copper, and manufactures thereof which were sold abroad, rose from an annual average of $1,600,000 during 1871-80 to more than nine million dollars during the late eighteen-eighties. Railroad cars—a distinctly new item—made their first conspicuous appearance during the seventies and by

1890 were moving to foreign markets at the rate of nearly three million dollars' worth a year. Cordage and cotton goods did likewise, their annual export value having risen from less than four million in the late seventies to fourteen million by the middle eighties.

As the century drew toward a close our diversified manufactured exports, which began to move out in quantities in the seventies, came forward with increasing rapidity in their search for foreign markets, though they still did not in their entirety contribute as much as farm products. Among the latter a number of interesting new developments took place. There was an astonishing export of refined sugar—a reflex of the growing imports from Cuba as well as from the native industry; the values rose from about one-half million in the early seventies to a record figure of sixteen million in 1885. Thereafter, however, they dwindled rapidly, at times actually dropping below a million a year.

One of the outstanding features of our agricultural exports was the heavy increase in the value of provisions, comprising meat and dairy products. As was indicated above, this came as a natural reflection from the growth of diversified agriculture. The figures are indeed impressive, having risen from an annual average of about thirty million dollars during the late eighteen-sixties to $136,000,000 in 1890. Indeed this was one of the outstanding features of our entire export position. It was stimulated in part by the rapid advance of refrigeration, the first refrigerator car having been put in use shortly after its invention in 1868.

Although cotton was still a leading item in our exports, its relative position declined, not so much because of the impairment of the economic status of the South by the war as because of the much more rapid advancement of the new West.

The opening of the twentieth century brought in a number of profoundly significant events which enormously increased the complexities of international contacts, quickened the transmission of commercial information and goods, strengthened the security of trade in all parts of the world, even in the most remote areas, provided invaluable new aids to navigation, and

in a hundred other ways put foreign trade upon a new footing.

It was no longer the old picturesque, adventurous calling, though it did not lack some of those features. In the main, however, the complete transformation of business methods throughout the world and the vast improvements of communication and transportation during the first quarter of the twentieth century have made foreign trade a secure and stable factor in business—in fact, the losses therein are currently rated as less than those in the domestic course of commerce in terms of percentages of the sums involved. All of these factors laid the way open for the small trader who had been previously kept out of the field because of the large risks and substantial capital involved. Overseas commerce which had hitherto been largely in the hands of big corporations who could provide their own protection, transportation facilities, overseas factors, etc., was now open to small operators as an attractive field for their modest endeavors.

One important angle of this development has been the establishment of official trade information and promotive agencies, a good part of whose energies are devoted to the assistance of small and less experienced operators. The Department of Commerce and Labor was established in Washington in 1903. The corresponding British service was remodeled along new lines in 1904, and similar developments were evident in the leading Continental nations.

A feature of this period of world trade was the very rapid advance of the British. One reason for this was the growth of their overseas investments which rose from £1,600,000,000 in 1895 to more than £4,200,000,000 by 1914. Perhaps the best indication of the growth of international commerce is the fact that its per capita volume for the population of the world rose from $11.80 in 1890, according to estimates by Day, to $24.50 on the eve of the World War.

It may be interesting to note the relative position of the leading rivals for this prize. At the opening of the century the United Kingdom was easily first with 22 per cent. of the world's commerce; her nearest rivals being Germany with 13 per cent., the United States with 12, and France 9. By the

outbreak of the great war, there had been a slight change in the shares of the European nations, that of Great Britain having fallen to 19 per cent., Germany having risen to 14 per cent., and France having declined to 8 per cent. In other words, the Germans gained at the expense of their two leading European rivals, the United States meanwhile having kept the same proportion, namely, 12 per cent. of the total.

While on this phase of the subject, it might be interesting to point out the transformations effected during the war period. By 1922 Britain had advanced her portion to 20 per cent. of the world's total, exports plus imports, but the United States in the meantime had risen to second place with 18 per cent. In 1926 both of these leading rivals had lost slightly in percentage, the British having 18 and the Americans slightly less than 16; their actual volume of commerce had increased substantially but not quite as rapidly as that of the rest of the world. Between them, however, they control to-day a third of the world's trade; each of them has more than Germany and France combined. The German share in 1922 was less than half of her 1900 portion, having reached only 6 per cent. of the total, but the rapidity of her stride since that date has raised her portion to 8 per cent. in 1926 and put her ahead of the French, who in 1922 had 9 per cent. but fell in 1926 to about 6 per cent. Germany seems to be well on the road toward recovering her pre-war position, relatively as well as in absolute volume of traffic.

The growth of American exports from about $900,000,000 in the middle nineties to more than $2,500,000,000 just before the war was one of the notable features of the world's commercial history during that period. The particularly striking factor in this nearly threefold expansion was in connection with the balance of trade which had averaged about $113,000,000 in favor of exports over imports during the last twenty years of the nineteenth century, whereas by 1913 the favorable balance was nearly $700,000,000. This was accounted for in part by the tremendous increase in exports indicated above, but also by the very heavy growth of the so-called invisible items on the import side, i.e., the debits owed abroad by the United

States for services rendered by foreigners either through loans of capital to American enterprises or sales to our tourists, or through transportation facilities provided by their ships, or by remittances by their citizens in the United States. Each of these items showed an astonishing growth during the decade just before the war and was in part responsible for the heavy increase in the favorable balance.

For example, the amounts of capital invested by Europeans in this country rose during the two decades before the Great War from $2,500,000,000 to about $4,500,000,000. The number of American tourists going to Europe increased from 95,000 a year during the late eighteen-nineties to 287,000 in 1913.

There were other contributions to this export growth in the lowering of prices during the latter years of the nineteenth century (in part associated with the domestic depression shortly before 1896), the expansion of industries incident to the Spanish War and the availability of their exportable surpluses thereafter, and lastly the sudden spurt in overseas interest incident to the acquisition of the Philippines and Porto Rico.

The tendency toward fabricated wares in our export, already noted during the latter decades of the nineteenth century, took on an even more prominent aspect after 1900. Whereas wholly and partly manufactured merchandise contributed about 23 per cent. of our exports in the middle eighteen-nineties, by the outbreak of the war they had risen to nearly 49 per cent.

The trade history of 1914-18 is obviously distorted and totaled abnormally because of the war-time reactions upon trade routes, monetary values, shipping conditions, and other elements which not only completely dislocated the traffic of the world but made statistical data highly uncertain for comparative purposes. It is possible, therefore, only to make the most general observations as to the commercial development of this period. The United States naturally enjoyed an advantage as a source of supply, not only for the European contestants but also for Latin American and Asiatic markets.

In connection with this factor, however, it should be carefully pointed out that much of the amazing increase of Ameri-

can exports during this time was not necessarily won at the expense of Europe through our replacement for European commodities. In fact, a close scrutiny of the figures reveals the fact that much of our extraordinary export during this time was in commodities which had hitherto been almost unknown quantities in international commerce from any source—for example, the great expansion of our exports of cheap automobiles, motion picture films, labor-saving machinery, ready-made clothing, and similar American specialties. Though they date largely from 1913-14 they are really the reflex of the enormous expansion of those industries in this country to supply domestic demand, rather than the attempt to take over the export trade of the sadly preoccupied European powers. Heavy gains were made by the United States in many once exclusive trade preserves of our European rivals, but the best proof of the fact that these gains were largely in new lines of trade in no way "stolen" from European merchants is the promptness with which the Old World traders restored their pre-war commerce in those same markets without embarrassing our own.

For instance, our share in Australian imports rose from 11 per cent. before the war to 22 per cent. in 1926, but meanwhile Britain's total volume of export to that valuable market increased substantially and was not seriously impaired, except in one or two minor commodities, by the growth of American commerce. The war-time expansion of American trade was, of course, to be expected. Our sales abroad rose from a little more than $2,300,000,000 in 1914 to the record figure of $6,227,000,000 in 1917. Even though much of the latter staggering total was due to inflated values and to very heavy shipments of war supplies, there was a general increase of movements in undreamed of proportions. The share of wholly and partly fabricated wares reached the record mark of 66 per cent. in 1917. Europe naturally provided much the larger market, taking an average of over 67 per cent. of our total trade during the war period.

Imports were correspondingly stimulated and rose in values from less than two billions just before the war to three billions

in 1918. Although many lines of once highly valued European luxuries disappeared entirely from our trade, nevertheless, their figures were more than compensated by the enormously increased payment for raw materials for war industries brought in from Latin America and the Far East.

An outstanding factor in our foreign trade position during this period and, in fact, since the war, has been the complete alteration of many trade routes. For example, a number of bulk raw materials which have always figured conspicuously in our imports formerly came to us largely by way of European trading centers—such commodities as rubber, vegetable oils, tin, wool, cacao, furs, dye-woods, etc. To-day, however, the larger proportions of these necessary commodities are brought directly from the production areas in the Far East and Latin America. The American consumer has thus been saved some important charges in extra transportation, commissions of middlemen, longer credit necessary to cover the commodities in transit, etc.

This change accounts in part for the astonishing increase in the values of our imports from Asia and Latin America. In fact, the sales of ten selected countries in those regions to the United States have increased some 362 per cent. since 1913, whereas their sales to the rest of the world have increased only 87 per cent. in that time. Another interesting phase of our new post-war trade is the growth of exports of a series of relatively new native industries, which were inaugurated during our war-time isolation from Europe and were given further sustenance by the protective tariff inaugurated in September, 1922. This includes a number of important lines of chemicals, textiles, fine hardware, precision instruments, etc., which are gradually developing substantial figures in our export columns.

One of the leading features of our trade position since 1914 has been the profound influence of the change of the United States from a debtor to a creditor nation in world finance. This was due to a combination of factors, including the tremendous expansion of our prosperity and resources in general, the transfer of the ownership of quantities of American securities from European holders to American, and the deficiency of

European capital for the exploitation of the new lands of Latin America and the Far East and for the rehabilitation of the sadly shattered economic fabric of the Old World.

As one indication of this it might be noted that American investments in Latin America which had totaled about $1,250,000,000 in 1913, rose to approximately five billion in 1927. A further factor in this matter of the general trade balance was the revival of American shipping available for foreign trade, which rose from about one million gross tons in 1914 to more than ten times that amount by 1920. Although there was a natural recession immediately after the war, nevertheless, the proportion of our total commerce in both directions carried in American ships has in recent years been averaging about 35 per cent., a figure that is higher than any since 1870.

The post-war position of the trade balance has been significant. In the years just before the war the excess of exports had averaged about $430,000,000, reaching $750,000,000 in 1913 as noted above; and during the war this was multiplied many times, reaching a peak of over four billions in 1919, with an annual average of over a billion during 1921-25. Much of this was accounted for, of course, by tremendous loans to the Allies, investments abroad, heavy increases of immigrant remittances and of tourists' expenditures. The latter item rose to $360,000,000 in 1923, which has been more than doubled in 1927, the total now standing at not less than $780,000,000, according to preliminary estimates. The favorable balance has been modified somewhat since the abnormal post-war years, although it still stood at about $700,000,000 for 1927, accounted for largely by the continued heavy increases of these same invisible items.

There have been a number of striking changes in the geographical distribution of our foreign trade in recent years. In the early decades of the nineteenth century, the exports were highly concentrated in a few European countries, whereas imports were widely diversified. The situation is now materially modified and exports are becoming more widely scattered. Europe, which with the adjoining territory of the Near East, was taking some 63 per cent. of our pre-war exports, now

absorbs less than 48 per cent. Latin America is gradually increasing her share, taking about 18 per cent. as compared with 14 per cent. during 1910-14. Canada has increased her portion from less than 15 per cent. to about 16 per cent. The Far East, including Australia, now takes the same as Canada, namely, 16 per cent., as compared with less than 8 per cent. before the war.

In other words, Europe is declining steadily so far as its relative position is concerned; Canada and Latin America are advancing very gradually, but the Far East is coming forward at a decidedly sharp rate as a market for American exports. It is interesting to note, incidentally, that the British Empire takes at least 43 per cent. of our total export trade, which would serve as an indication of the importance of the buying power of that collection of commonwealths in our commercial position.

In the matter of imports, there have been several even more striking changes. In the first place, the European participation in our purchases from overseas has fallen from a pre-war average of about 50 per cent. down to 29. Latin America, meanwhile, has remained almost constant, contributing about 25 per cent., while the trans-Pacific countries doubled the relative proportion which they supplied, raising their quota from approximately 16 per cent. in 1910-14 to 32 per cent. to-day. The East is, therefore, the leading supplier of our needs from overseas, having displaced Europe and Latin America, and although this is in part due to the extraordinary rise in the price of rubber and a few other major materials coming across the Pacific, it is quite evident that in actual volume, as well as values, our imports from the East have taken a premier position. There has been a steadily increasing proportion of raw materials in our import trade as compared with finished manufactures because of the growth of American industries, and the East is contributing heavily to this highly valuable traffic.

It is interesting to note that about 50 per cent. of our imports and nearly 40 per cent. of our exports are made up of textiles and vegetable products. In fact, textile raw materials consti-

tute both the leading export and one of the two leading import wares, namely, raw cotton and raw silk, respectively.

Closely linked with this has been a group of vegetable food products—breadstuffs among the exports, and sugar, coffee and fruits among the imports. Rubber, which in recent years has stood at the head of our import list and bids fair to do so because of the enormous increase in our automotive industry, is, of course, also a vegetable product. Standing close to this great group of vegetable raw materials are a list of non-metallic minerals and metals represented in exports by the very heavy shipments of petroleum products in both directions—imports of crude oil from Mexican, Colombian, and Venezuelan wells (largely owned by American capital), and exports of refined products.

Foreign trade is becoming more and more widely appreciated as an invaluable stabilizer of our general business position. This has been demonstrated again and again throughout the century under review, and never more clearly than in 1927 when several industries, having suffered a slackening of domestic trade, found a most helpful corrective of their position through a more intensified exploitation of overseas markets. These activities accounted in part at least for the increase of our overseas sales to approximately $4,925,000,000, which represented an increase of 2½ per cent. in value over 1926 and of 18 per cent. in volume, the discrepancy being due to declining prices.

Our exports of finished manufactures have increased in each of the last five years and now stand at over 50 per cent. above 1922 in value. In fact they now comprise nearly 60 per cent. of our total exports as compared with 30 per cent. in 1901-05. This is particularly gratifying because the success of our overseas sales in these lines has, in the first place, been built up largely by small or medium-sized establishments since the war, whereas it has been often said that so far as manufactured exports were concerned in pre-war years about fifteen companies supplied nearly 90 per cent. of their total volume.

A second gratifying feature of the situation is the fact that this expansion of our foreign commerce has been determined

largely by the extent and effectiveness of our sales efforts. Unlike raw materials, the overseas sale of manufactured goods depends upon intensive export drives; they are not self-selling or subject, to any appreciable extent, to the vagaries of competing crops, weather conditions, famine, and other factors beyond human control. A typical instance of fabricated exports has been in the automotive field, which includes not simply a few large concerns but also hundreds of small firms dealing in parts, accessories, etc. The 1927 total in this whole group exceeded $406,000,000, which represented a growth of at least 21 per cent. over 1926. In fact, during the past five years our exports in this group have increased by about $222,000,000, or more than 120 per cent., i.e., from $184,300,000 in 1923 to $406,000,000 in 1927.

Foreign trade, then, has become a modest but invaluable part of our whole economic system. It has served again and again as a stabilizer of our domestic position and as an indicator of the general trend of our commercial and industrial growth. Because of its far-flung variety of contacts and of its innumerable participating industries, it is no longer likely to suffer hectic gyrations due to the whims and shifting plans of a few participants, as was the case in pre-war years. Even though it may not contribute more than perhaps 10 or 11 per cent. of our total commercial life, that modest margin has frequently saved more than one major industry from distress. The nation's business men are becoming "foreign-trade minded," not through any emotionalism or flamboyant patrioteering, but simply because they have seen the necessity of appraising and being guided by the practical dollars-and-cents value of this steadily strengthening contributor to our entire commercial well-being.

V

MINES AND MINING

By H. Foster Bain

Secretary, American Institute of Mining and Metallurgical Engineers

NO more fundamental change has taken place in the United States in the past century, none which has touched more intimately the daily life of all the people, nor any which has resulted in a greater enlargement of the powers and opportunities of the individual man, nor which has to a greater degree augmented the wealth and increased the strength of the nation, than the great output of minerals which has characterized the period. Nowhere else are minerals obtained in such quantity and used so freely as in the United States to-day. No other people enjoys so large a per capita production and consumption of the power minerals, the structural materials that come from the earth and the minerals which enter into the chemical industry.

It has often been said that the present is the century of power but in a larger and truer sense it is the century of minerals, for to all but an inconsiderable degree the power with which our work is now so largely done not only comes from consumption of the power minerals but is only possible of development and control because of the coincident free exploitation of our metallic resources. Frank J. Goodnow, president of Johns Hopkins University, coined a useful phrase when he spoke of the Chinese as having a "vegetable civilization," meaning thereby that for the materials upon which it depends, the people turn to the vegetable kingdom. In a larger and even truer sense ours is a mineral civilization for it is our large and free use of the minerals that make up the crust of the earth which differentiates the life of the people of the United States in the year

1928 from that of their ancestors of a century and more ago here, and of peoples in other countries and at other times.

Taking the world as a whole, it raises or captures each year the food that it eats that same twelve months. The carry-over is insignificant and a permanent accumulation of food is unthinkable. Similarly with raiment, though the period from production through use to destruction is slightly longer. All the cloth handed down from all the preceding centuries would supply modern trade demand but a few days probably. It is not so with minerals. While the power minerals are consumed in use they leave their marks on the world. Of the other minerals, a considerable portion of each year's output is added to the world's stock and by and large whatever the world has of permanent wealth, of tangible heritage from the past, is represented by the metals and minerals now in use. The billions of gold stored in the vaults of the banks and on which the world's monetary systems depend, represent the accumulated accretions, the painful savings of centuries; but much the larger part was added to that store in the last hundred years. Of the present stocks of steel, copper, lead, zinc, aluminum, even a much smaller portion had been accumulated in 1828. Indeed, zinc was then a rare metal not produced at all in the United States and Hall had not yet by a number of decades carried out the experimental work which gave us the wonderful light metal —aluminum.

In the year 1828, life was still simple, and difficult. The industrial revolution had but barely begun in America. It was but ten years before that Fulton made his trip on the Hudson and it was still ten years before the first transoceanic voyage was made by a steam vessel. Railroads were new and experimental. The Baltimore and Ohio had but resolved to cross the mountains to the west, using horses for motive power and hauling the small cars up the slope with stationary engines. It was not until several years later that Peter Cooper, as shown at Halethorpe last autumn, convinced the directors of that enterprise that steam locomotives were feasible. The canal boat and the horse-drawn wagon on land and the sailing vessel of the sea were still the all but undisputed means of transportation,

and all these were made almost entirely of wood with only a minimum of hand-wrought iron entering into their construction. Tools in any industry were few and precious and cooking pots as well as rifles were cherished possessions. Wood was the common material used in construction, supplemented to a minor extent and in the case of the more important and expensive buildings and bridges by stone and brick. Glass was not a common luxury. Indeed, as late as 1831, the most extensive glass-making plant in the United States, that at Dyottville, Pennsylvania, produced but 1,200 tons in the year and even that output went largely into making bottles. The only chemical industry founded on minerals was salt-making and in many of the Western states the lands containing salt springs were still for some years reserved from sale as representing a common heritage of irreplaceable value; the first conservation legislation applied to minerals in this country. It was then necessary to burn the forests to obtain pearl ash, which was then as now the basis of manufacture of alkalies and a necessary ingredient in the common soft brown soap that even our own grandmothers for long years after boiled down in the big iron wash kettles that later became common.

Chemical industry, at least so far as mineral technology is concerned, practically grew up around chrome production in Baltimore and it is just a hundred years ago, in the summer of 1827, that Isaac Tyson, Jr., saw in Belaire market, at Baltimore, a cart containing a cider barrel held from rolling about by means of some heavy black stones. They were chromic iron from Bare Hills and by a rare coincidence he was possibly the only American who would have recognized them or known their value. Previously the little chrome used in industry reached Europe from the Ural region by a voyage down rivers and across Arctic seas lasting two years or more. Tyson, stimulated by the recognition of the local source of ore, founded chrome works and up to the time of the Civil War Baltimore supplied the world. That city is to-day a great center for chemical industry as a result direct and indirect of this primitive start and the chrome industry has grown till in 1926 the world used 340,000 tons and chrome steel, and chrome

salts and chromite refractories are essential to many industries. A similar story could be told of many other metals and ores which in the last century have become the basis of great businesses.

Coal, which has so aptly been called "the mainspring of civilization" and which now does much the greater part of the work of the world, had been discovered by Father Hennepin on the Illinois River near the site of the present city of LaSalle in 1679. As early as 1720, coal had been mined in Nova Scotia and in beginning years of the nineteenth century coal mining became locally important in eastern Virginia. As has been often related, however, the blockade of the port of New York by the British fleet through much of the period of the War of 1812, broke up the trade in Virginia coal and led to the development of the anthracite mines in Eastern Pennsylvania. Despite the years since the discovery of coal in Illinois and its widespread presence in our country, the total output in 1828 was but 95,980 tons of anthracite and 100,480 tons of bituminous—not enough now to heat the government buildings alone in Washington and less than the amount used annually in many individual power plants. Coal had not yet been seriously put to work either to produce power or in metallurgy. Fuels were used mainly in heating houses, and cold rooms in winter were still regarded as but necessary stimulants to manly virtue and high thinking. Marcus Bull presented a paper before the American Philosophical Society in Philadelphia, estimating that of the total consumption of fuel for the year, 80 per cent. came from wood, 3 per cent. from charcoal, a little over 14 per cent. from anthracite, and less than 2 per cent. from bituminous coal.

It is interesting to contrast those days of household industry and all but fuelless manufacturing with the present. In a normal year the United States now produces and consumes in round numbers 600,000,000 tons of coal, of which 80,000,000 is anthracite and the remainder bituminous. This amounts to 43 per cent. of the world's total. The coal comes from thirty states and from 7,000 to 9,000 mines, the number depending on the activity in the particular year considered. From the

point of view of tons dug, the coal miners of the United States do each year a bigger job than the digging of the Panama Canal. The value of the coal at the mines is approximately $1,750,000,000 or, roughly, four times the cost of the Canal, and the price of the coal when it reaches the consumers is about $5,000,000,000, or nearly half the value of all the crops raised on the farm lands of the country. Yet coal mining is but one branch of our mineral industry.

From another point of view the fuel output of the country, and of this coal forms much the larger part, is even more important. Two pounds of coal properly utilized will do the work of one man one day and a short ton is therefore equivalent to 1,000 man-days work. The work of the world is no longer done, save as to a minor fraction, by men's hands. Men have become the directors of work rather than workmen. To measure the real power of a country it is therefore necessary to take account not only of the population but of the fuel consumed and water power developed. The United States leads the world with a per capita consumption of coal amounting to between five and six tons and a domestic consumption of 255,493,000 barrels of fuel oil in addition. The United States now does nearly half the work of the world and with a population of 105,000,000 has a work output equivalent to a population of 3,805,000,000 million hand laborers. By way of contrast it may be remarked that China, with four times the population, has barely one-seventh the work output. It is this enormous use of the fuel minerals, supplemented by 12,000,000 horsepower developed by waterfalls that have been put to work, that makes it possible for our people to have the variety and amount of goods that characterizes the present and to continue to accumulate more while the working day is made shorter and shorter and the labors of each steadily lightened.

Coal, however, alone is incapable of making this great change in the lives of people. It must be supplemented by an abundant supply of metals, chief among which is iron, at the same time that it would be impossible to mine and transport the coal, to burn it, or otherwise put it to use without this second mineral in service to man. In 1828, such iron as was

made was produced in small furnaces using charcoal as fuel. The hot blast had not come into use and it was much later that it made possible the use of raw anthracite. As early as 1817, Colonel Isaac Mason had, it is true, used coke to refine iron in a puddling furnace for the first rolling mill west of the Alleghenies and in 1819, coke had been tried in the Bear Creek blast furnace in Armstrong County, Pennsylvania, but only a hardy few dared maintain that coke suitable for blast furnace use could be made from American coals. In 1825, the Pennsylvania Society for the Promotion of Internal Improvements had, it is true, sent William Strickland to Europe to investigate actual coke making and in 1834 announced that the process was now well understood. When, however, the Franklin Institute in 1835 offered a prize for making the greatest quantity of iron, to be more than twenty tons, through the use of coke, it was not until the winter of 1836-37 that this was claimed by Oliphant, and he promptly reverted to the use of charcoal. It was indeed not until 1839 that the Lonaconing furnace of the George's Creek Coal Company at Frostburg, Md., began to use coke regularly and rose to the proud height of 62 to 92 tons of pig iron per week. As late as 1849 there was not a single coke furnace in blast in Pennsylvania. Now substantially all pig iron is made with coke, anthracite as a furnace fuel having come and gone, and charcoal being used to but a limited extent for making iron of peculiar properties for especial use. In 1927, 33,289,000 tons of finished steel and castings were produced in this country, two-thirds being absorbed by construction, the railways, automobile manufacturers, oil and mining industries, but the remaining third being essential to many other industries, 5½ per cent. going directly to use in agriculture.

In these days of corporations of widespread and varied activities it is difficult to realize on what small scale iron making, then as now our greater metallurgical industry, was conducted a hundred years ago. In 1829, Pittsburgh, now the world's great steel center, already had eight rolling mills—but altogether they used but 6,000 tons of blooms and 1,500 tons of pig iron, while the nine foundries of which the city then boasted

used but 3,500 tons of iron. As late as 1849, the 298 blast furnaces in Pennsylvania made but 253,370 tons, an output per furnace for the year that has been equaled in a day by individual American furnaces. In 1830, a blast furnace that produced twenty-eight tons of pig iron in a week was doing good work; now individual furnaces make 1,000 tons in a single day. In the same year, the total output of steel for the entire country was 2,000 tons, but that was enough to usher in our rolling mill era. Now, on the telegraphic order received in the afternoon and to catch a particular steamer in the export trade, 300,000 tons of a single shape have been rolled in one night shift.

In 1828, steel was still made in small lots by cementation. It was not until 1858, nearly a third of a century later, that Sir Henry Bessemer achieved success in making cast iron into steel by blowing air through the molten mass and so opened the way to making steel cheaply and on a quantitative basis. Now, already, Bessemer converters have largely disappeared from use and the open-hearth furnace is almost universal. The day of the small furnace and limited output is gone. With them as a source of our chief structural material our present world of business and industry could not exist, for steel now forms the skeleton framework within modern civilization. Without it the whole range of power-generating and power-using industries would be virtually impossible. Modern building requires enormous quantities; speedy and abundant transportation are alike dependent upon it; communication whether by telegraph, telephone, or radio, is similarly conditioned. The tools of industry and the implements of war, the thousand and one essentials and conveniences of daily life are all made in whole or in part of steel. The ease and certainty with which under ordinary conditions of trade it is available to any country have led us to forget how essential it is, but in times of war or general trade disturbance a shortage of this material promptly drives home the fact that steel is necessary to modern industry. In the world as it now is no nation can be strong in time of peace or safe in time of war without an adequate supply of this basic material.

Of the metals other than iron, the United States in 1828, though even then considered rich, produced quantities now considered to be insignificant. The figures are not available for calculating the total output for that year but a few illustrations will point the contrast between then and now. It should be remembered that the Mexican War had not yet been fought and accordingly California and the Southwest were still given over largely to the Indians and the Friars. The prairie country and the Rocky Mountain region were, it is true, largely within our then national boundaries, but exploration had but begun and mining was long to wait. The great copper and iron mines of the Lake Superior region were not discovered till long after, though metal from the copper ranges had been worked by natives in prehistoric times. The West was then in the Mississippi Valley, and in Southeastern Missouri, Southwestern Wisconsin and Northwestern Illinois hardy pioneers were mining lead. In Missouri, mining had been conducted in a small way since the John Laws Company of the West sent out Renault and LaMotte in 1820, and in 1788, Julien Dubuque began mining by permission of the Indians in what is now Iowa. In 1807, all the mineral lands in the Upper Mississippi region were reserved by the government and in 1822 licenses to mine began to be issued and with the coming of steamboats on the Upper Mississippi the region became one of intense mining activity. In 1834, the miners refused to pay the government license fees and in 1847 the system was given up. From 1820 to that year, the Galena-Dubuque region was the principal metal mining district in the United States with an output rising to an average of 21,000 tons per year for the decade from 1841 to 1851. It was the pioneer Western mining district and retained its prominence until the discovery of gold in California in 1849 drew from it, as from all the rest of the country, the adventurous spirits that had made it famous.

Aside from these mines in the Mississippi Valley, lead, copper, gold, silver, and other metals were mined in the Appalachian Mountains and in the Piedmont plain east of them from the Canadian border to Georgia, though the individual operations were small and few of the mining districts are now

important. A hundred years ago zinc was not mined, but since then two great deposits have come into production in this Eastern country, that in New Jersey mined by the New Jersey Zinc Company since 1848, and the Mascot in East Tennessee, which after various desultory attempts to develop was put on a large productive basis about 1913. In Wisconsin and Missouri, zinc did not become important until 1870. The attention which led to production was not attracted to the Lake Superior copper region until the publication of Douglass Houghton's report in 1841. It was fully ten years later that serious attempts began to mine the copper near Ducktown, Tennessee, the only large copper deposit known in the southern Appalachians.

Early mining in the Southern states was mainly for gold and in North Carolina and Georgia in particular a gold mining industry was built up which reached its maximum between 1828 and 1845, after which the miners were rapidly attracted to the richer fields in California. From 1804 to 1827, North Carolina furnished all the gold mined, amounting to $110,000. In 1829, $2,500 was deposited at the mint from Virginia and $3,500 from South Carolina, while in 1830 Georgia came in with $212,000. Such large amounts of gold were held to justify establishment of a mint but even then political considerations seem not to have been unknown, since in place of one, three were opened, in Charlotte, N. C., Dahlonega, Ga., and New Orleans, La. The latter coined hardly any native gold until that from California began to arrive.

Gold mining in California began in 1849 and in 1850, 2,418,750 ounces, worth $50,000,000, was taken out. The mines yielded at nearly this same average annual rate until 1870. Meanwhile, discovery of the rich Comstock lode on the east side of the Sierra Nevada ushered in a silver production that nearly upset the world's established ratio of precious metals. It was these western mines which, as Lincoln said, furnished the gold and silver that saved the Union in the period of the Civil War.

En route across the continent to California, the prospectors opened much of the Rocky Mountain and Great Basin region and more mines were found by those returning from the Pacific

or who scattered out into the mountains as the richer placers were exhausted. It was the lure of gold in California that opened up the whole West. Colorado, Montana, Utah, Arizona, all the great mountain states, were pioneered by men who were attracted west by the gold mines of California, and in America, as around the world, civilization followed the pick.

So intimate have become the relations of our daily life to the output of the mines, and so consistently has the amount of mineral used per capita increased as the years have gone by, that from time to time grave doubts have been expressed as to the ability of the world to keep up the pace. In one hundred years the amount of iron used per capita in our country has been multiplied by 119; it has doubled in twenty years so that the rate as well as amount is increasing. This is true to a greater or less degree with the other metals and minerals. As F. G. Tryon and Lida Mann pointed out in their excellent discussion of "Mineral Resources for Future Populations":[1] "In the hundred years from the close of the Napoleonic wars to the outbreak of the World War, the white population of the world increased three-fold, but the output of tin increased 26-fold, of copper 63-fold, of the mineral fuels 75-fold, and of pig iron over 100-fold. Lead and zinc showed a corresponding increase. In 1815, aluminum and the ferro alloys (nickel, vandium, tungsten, manganese, and chromium) were known, if at all, as curiosities. The mineral fertilizers also are a development of the nineteenth century."

C. K. Leith has stated the same facts in another way as below:[2]

"The world has used more of its mineral resources in the last twenty years than in all preceding time, and there is nothing to indicate a slackening of the acceleration which has occurred during this period. The production of oil, for example, is now as great in any one year as for the ten years preceding 1900. . . . The last twenty-five years has seen as much gold produc-

[1] Pollak Publications, Vol. 5, p. 114.
[2] Political Control of Minerals, Foreign Affairs, New York, Vol. 3, p. 541, July, 1925.

tion as the four hundred years following the discovery of America."

Others have written in similar vein but as yet it is the engineers only who generally appreciate how increasingly dependent upon minerals the world has become and how with a fixed supply and an irregular distribution our economic and political problems will require a larger and larger knowledge of them and a more general appreciation of their importance. Without coal, oil, or gas the work of the world as we know it would cease. The locomotives and ships would stand idle. All but a few of our generators would cease to hum and our lights would flicker out. Without our metals our railways, ships, bridges, and houses would be largely impossible, our machines and tools would disappear, and without our stones and other minerals man could but return to his former savage life as a beast. The development of the mind perhaps is what sets us off from other animals, but it is only man who uses minerals and without them he would have neither the means nor the leisure for mental culture. Except for the minerals and the arts of mining and metallurgy founded on them, there could be no civilization.

VI

STEEL—ITS PART IN AMERICAN PROGRESS

By Charles M. Schwab
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STEEL. What is the image which this word raises in the mind of American readers? Probably the average man when he thinks of steel has a vision of huge masses of ore and pig iron; of ponderous machinery and towering structures. He may think beyond these tangible things and try to conceive the hundreds and thousands of men and the billions of dollars of capital concerned with the industry. What he is likely to overlook is the fact that steel is the basis of present-day American civilization; that it touches the daily lives of every one of us; that it is a constant aid to persons in all walks of life and in small affairs as well as great.

Many volumes have been published giving facts and statistics about the steel industry. Its history and the details of its present development are spread out where he who will may read them. It is not the purpose here to repeat these facts and figures. Space is lacking for an adequate treatment and the importance of the subject forbids a hasty summary. The present purpose is to point out something of the human story of steel and the effects of the steel industry upon the civilization in which we are living. The historical and statistical facts included will be only those which aid in carrying out that purpose.

Among those American industries rightly termed basic, steel occupies a dominant position which few will dispute. The steel industry has an estimated capital investment of $5,000,000,000. It employs one and one-half million people who with their de-

pendents make up something like 6 per cent. of the population of the country. The value of iron and steel and their products is estimated to be nearly ten billion dollars per year. Even these figures do not tell the whole story, for steel is closely related to many other industries, the fortunes of which are bound up with its own. Its raw materials and finished products make up a huge proportion of the freight carried by the railroads. Its demands for coal, coke, limestone and other commodities, in addition to iron ore, afford the main support of many contributing producers. Its payrolls constitute one of the main props of the purchasing power which is the foundation of business prosperity. Without steel, industry in America on its present scale would have been impossible.

The production of steel in 1927 was estimated at 32,039,000 gross tons, of which the building and construction industries took 22 per cent., the railroads 19 per cent., the automotive industry 14 per cent., oil, gas, water and mining 8½ per cent., export 6 per cent., agriculture 5½ per cent., food containers 5 per cent., machinery 4 per cent. and all other uses 16 per cent.

The development of the steel industry might be looked upon as a chapter in the industrialization of America—as a record of mere physical accomplishment. It is all that but more. In reviewing the achievements of the steel industry we cannot escape the conviction that it is one of the bases for our high standards of living. An evaluation of its contribution can best be made by taking stock of what it has done for our economic life.

In a broad sense the fundamentals in economic life are food, clothing and shelter. Present-day conditions make it proper to add transportation as one of the elements that has become an integral part of the whole scheme of social existence.

In the basic requirement of food, steel has contributed even beyond the primary stages of cultivation and harvesting. Through modern appliances it has greatly aided agricultural production and improved farm life generally. It has also facilitated the preparation, distribution and conservation of food products. In the early days of the Republic the vast majority of the population lived on the farms, toiling through

long hours with insufficient tools to raise the bare necessities of life for themselves and the relatively small number of dwellers in the neighboring towns. Through the use of machinery this has all been changed. A relatively small fraction of our population is now employed in feeding all of us on a scale of luxury and variety never before known. If it were not for the contribution that steel has made in machinery for the production and preparation of food, a majority of our people would still be on the land. The industrial era upon which our present well-being is largely based could scarcely have come about. It is probable, indeed, that in a machineless agricultural era it would be very difficult to feed adequately a population as large as that which now occupies the country.

No less dependent upon steel is the economic factor of housing. This goes far beyond the requirements of shelter; it embraces under our modern society adequate buildings of all kinds through which the complex channels of trade and commerce function. Modern business requires the concentration of large numbers of people in cities and other industrial centers. It is said that the metropolitan area of New York City now contains some nine million people. Such a concentration would be quite impossible if these millions had to live and work in old-fashioned buildings unsupported by steel frames. It is to steel largely that modern civilization owes the huge industrial building, the skyscraper and the convenient apartment house, and latterly there is evidence of steel being extended to the field of ordinary dwellings.

As to clothing perhaps some historical-minded reader may point out that steel is not as important as it was when "knighthood was in flower." However, our modern garments if not metallic in substance are nevertheless dependent upon the infinite variety of machines used in spinning and weaving, in garment making and in shoe manufacture.

When we come to the item of transportation our dependence upon steel is apparent and impressive. The close relationship between steel making and railroad building already has been pointed out. In our ship industry steel is indispensable. It was an important factor in our winning of the war through

the construction of emergency tonnage. It is equally essential to our shipping industry in times of peace, and will play an important part in reviving American shipping under the American flag. Automobile manufacture accounts for a huge tonnage of steel every year, while the growing industry of airplane production promises soon to become another important factor. Modern transportation, indeed, would be wholly impossible but for the use of steel as its principal material.

One might go on indefinitely in cataloging the phases of modern life toward which the steel industry has made indispensable contributions. Enough has been said, however, to justify the contention that the steel industry has been an important element in making for the standards of living enjoyed by American people to-day.

There is not much in the present make-up of the concerns which are supplying present-day steel requirements to indicate the steel industry as it existed at its inception in this country. To-day it can be said that the large majority of the industry's output is produced by not more than thirteen separate companies, whereas a few decades ago steel was produced in many small plants owned by individuals or small groups. Manifestly with the growth of these small unrelated units there grew up a competitive situation which influenced some of the more farseeing business men to look with favor upon bringing these units into closer coördination.

The need for this coördination became further emphasized as the supplies of raw materials in the isolated sections began to show signs of depletion and as the requirements grew with the expanding demand for steel. All of these factors brought about a concentration of the steel industry both from the standpoint of direction and location until to-day we find its major operations in four principal centers—in the East, in the Pittsburgh district, in the Middle West and the South. While the transition from the individual small units into the larger companies did much to stabilize the steel industry, yet even to-day there exists free competition with no one company having a productive ingot capacity of more than 40 per cent. of the total capacity for the industry.

The first consolidations of steel companies to attain impressive magnitude were the Carnegie Steel Company and the Federal Steel Company, the latter headed by the late Elbert H. Gary. These two companies by about the year 1900 were the dominant factors in the industry and were engaged in keen competition between themselves. They became the foundation upon which was built the United States Steel Corporation which remains to-day a monument to the far-seeing genius of the elder J. Pierpont Morgan and Judge Gary and others.

The present Bethlehem Steel Corporation, now the second largest company in the industry, was also constituted through the acquisition of many separate steel companies. To the original Bethlehem Steel Company was added between 1916 and 1923 the Pennsylvania Steel Company, the Maryland Steel Company, the American Iron & Steel Manufacturing Company, the Lackawanna Steel Company, the Midvale Steel & Ordnance Company and Cambria Steel Company.

That these companies had an impressive list of accomplishments to their credit in steel prior to their acquisition by Bethlehem is shown by the fact that the first steel rails made commercially in this country were rolled by the Cambria Iron Company at Johnstown, Pennsylvania, in 1867, from ingots produced at the works of the Pennsylvania Steel Company at Steelton, Pennsylvania.

Youngstown Sheet & Tube Company, Republic Iron & Steel Company, Wheeling Steel Corporation, Crucible Steel Company of America, and many of the other existing steel companies have likewise been formed through consolidations of smaller units.

Throughout these consolidations the plants originally operating have for the most part been kept intact. However, they have been largely rebuilt and modernized as processes have been developed and new capital has been available for the industry. In this way the volume of output has been kept up to the needs of the markets, while through the use of additional capital and machinery, and the adoption of more efficient methods and better management, costs have been successively reduced with corresponding benefits to producers in the form of better

products at lower prices. Thus the growth of the steel industry and its consolidation into a comparative small number of companies have been of benefit not only to the owners and managers of the business but to consumers and to the American public at large. It is chiefly through these methods that the steel industry has been able to play its part as one of the main bulwarks of modern civilization.

In recent years the process of mechanization and electrification has gone forward with redoubled speed. Between 1914 and 1926 it has been estimated that upwards of $1,650,000,000 was spent in rebuilding and modernizing the plants and properties of the larger steel companies.

It is fortunate that our steel industry has been able to expend this huge sum, for as a result of it the consumers of steel have been enabled to procure their requirements for much less than they would otherwise have had to pay and have thus been fortified for competition not only in home markets but in foreign fields as well.

In this process the steel industry itself has not always been as fortunate as its customers, since in spite of the large increased capital investment necessary to bring about these up-to-date conditions resulting in savings in cost of production the steel industry has received approximately the same margin of profit for its products as was received before these expenditures were made. For example in 1913 the earnings available for interest and dividends of the ten largest steel companies were equal to $6.13 per ton of ingots produced as compared with $6.21 per ton average for the three-year period, 1924, 1925 and 1926, and only $6.69 per ton in 1927 (a record year up to now in point of production).

During the period between 1913 and 1926, which includes the war period of inflated commodity prices, the average price of steel products increased approximately 35 per cent. During the same period the average price of the three products representing the largest tonnage—bars, structural shapes and plates—increased approximately 28 per cent. These increases compare with the average increase of 51 per cent. in the prices of all commodities. It thus becomes evident that since steel

prices increased less than other commodities, the consolidations and improved processes resulted in giving to the public advantages that are not generally realized.

In this process of development, in the course of which the steel industry has been able to pass on to its customers the economies effected by consolidations and huge capital investment, the industry has been aided by steadily increasing domestic demands resulting from the development of the country. These demands have created an enormous market for machinery, for structural steel for automotive and other manufacturing, and for railroad equipment. There is a peculiar interdependence between the railroads and the steel industry since the railroads are required to haul a large part of the five tons of raw materials required for each ton of steel produced, while the railroads on their part consume on an average of about 25 per cent. of all finished steel products.

The American steel industry is more than national in its scope. Its products are being shipped to nearly every nation of the civilized world.

Throughout the expansion of the steel industry its products have taken constantly new forms as fresh demands have been dictated by changing conditions of industrial and social life. The beginning of the railroad era profoundly affected the whole subsequent development of the steel business. More recently the manufacture of automobiles, which was negligible until relatively few years ago, has grown until it now accounts for 14 per cent. of the entire steel output, being, in fact, the third largest consumer of steel. Moreover the automobile by creating requirements for improved highways and new bridges and tunnels is really responsible for an appreciable portion of the steel consumption credited to building and construction. Likewise the development of the oil industry, due largely to the automobile, has created an important demand for steel. There is no indication that the automotive industry is close to the elusive "saturation point." It is fair to expect that it will continue to expand and to call for larger supplies of steel.

The automobile long since ceased to be a luxury; it has become a necessity of our business and social life and an essential

factor in the improved standard of living of the American public. Its economic importance to the steel industry goes beyond simply furnishing an outlet for its steel; its use by the steel worker has had a tremendous beneficial effect upon his living and working conditions. It has largely solved the fundamental problem of transportation for the worker and has greatly widened his working area; he no longer is at the absolute mercy of the neighboring employer for work but the whole territory for miles around is now his to explore. And the employer too has benefited. It has solved for him many of the social problems which a congested labor force around the plant always presented. It has helped to do away with the old type of steel town with its crowded and oftentimes unattractive environment, and has allowed the workers a wider choice for home selection so that to-day the average steel community compares very favorably with the best of American towns and cities of corresponding size.

The history of the development of steel reveals that its growth has been in two directions. As the demands of society have necessitated materials and structures of greater strength, less weight and added safety, it has found an important application as a substitute for other materials. It has also taken a leading part in lending itself to utilization in the development of many new products. From both of these sources the per-capita consumption of steel in the United States has increased from 280 pounds in 1900 to 740 pounds in 1926.

Anticipation of future changes in the demand for steel necessarily takes us into the perilous field of prophecy. The iron makers of a generation ago were accused of irresponsible optimism when they predicted what they thought would be the developments in their industry and yet in the brief time that has elapsed the industry has far surpassed their wildest expectations. Perhaps the most hopeful prophecies that we can make now will fall equally far short of reality. It is certainly safe to predict that the requirements for construction will continue to expand since road building has yet far to go and may even involve the construction of national highways that will provide direct express communication between all important centers;

the demands for bridges and vehicular tunnels are still far from satisfied, while the proposals for "Super-Cities" with multiple street levels to take care of traffic congestion are beginning to approach tangible form. Moreover it is probable that airplane manufacture will expand rapidly in the next few years, and it is even conceivable in that respect that we are at the beginning of another industry which may parallel the development of automobile making.

History does not record the date at which men first used iron or the name of the man who first found out the secret of extracting the metal content from the ore. Probably iron in some form and by some tribes was used before written history began. For an extensive use of this metal (which some scientists estimate makes up as much as one-fifth of the earth's bulk), the world waited until the advance of civilization created a need. Even then men used it timidly and with many mistakes. England, with millions of tons of coal just beneath the surface of the ground, first smelted iron by the use of wood as fuel, and it is interesting to note that in 1581 laws were enacted prohibiting the operation of iron furnaces in certain parts of the kingdom lest by the extravagant use of wood the forests would be destroyed and the nation be left without resources of lumber for the building of ships for the navy. A little later the use of coal for smelting iron began and in the eighteenth century the blast furnace was invented.

In the meantime English colonization in the New World had begun. The settlers in Virginia scoured the wilderness in search of gold. They did not find it, but they did find iron ore, and in 1619 the first smelting furnaces in what was later to become the United States were built on Falling Creek, a branch of the James River. This early enterprise met a tragic end a few years later when the Indians massacred the workmen and their families and destroyed the furnaces. Soon, however, iron was discovered in other colonies and rude furnaces were built at various points, particularly in New England, New York and Pennsylvania. Some of the cast iron produced in these furnaces was shipped to England, and some of it was utilized by the colonists. Nail making became an important

household industry in thrifty New England, where many a pioneer farmer built a tiny forge in his cabin at which he and his children hammered out nails during the long winter evenings.

The crude beginnings of iron casting came at about this same time, and the first iron pot cast in America was made at Lynn, Massachusetts, in 1645. A century later cannon were being cast for use in the war against the French, and still later colonial iron furnaces produced artillery and cannon balls for the use of Washington's army. The great iron chain which was suspended across the Hudson River at West Point in 1778 to prevent the passage of British war vessels was forged in New York State.

With the growth of the new nation, its westward spread and the growing need of iron for the development of the struggling pioneer civilization, the iron industry began to centralize itself in a few favorable locations. The ore deposits early discovered in Virginia and New England soon became exhausted or were found to be of little importance. By the beginning of the nineteenth century iron smelting had attained considerable proportions, particularly in eastern Pennsylvania, where ample supplies of both ore and wood were found, but in the vicinity of Pittsburgh a small furnace set up in 1792 was abandoned two years later for lack of ore. Not until after a second attempt, when a foundry was erected in 1803, did Pittsburgh become the center of a permanent iron industry.

Subsequent discoveries of ore, new processes requiring supplies of coal, and the changing market conditions in a rapidly developing country accounted for the later distribution of the principal iron workers at central points in the East, Middle West and South.

What was later to afford a powerful impetus to the growth of the iron industry came with the opening of the railroad era. The first regular railroad in the United States was begun in 1828 and two years later the first thirteen miles of this road was open to traffic. In 1840 the United States had a total of 2,818 miles of railroad. By 1860, this had increased to somewhat more than 30,000 miles.

Railroad tracks, at first usually built of wooden beams to which thin strips of iron were forged or nailed, soon came to be constructed of iron rails. These rails at first were imported from England but in 1843 the first iron rail was rolled at the Mt. Savage rolling mill in Maryland. This rail weighed forty-two pounds per yard. In 1849 the production of iron rails reached 24,318 tons.

The great period of railroad building came soon after the Civil War and since then the railroads and the steel industry have stood side by side among the most useful servants of American civilization.

In the meantime another industry destined to play an important part in shaping the future of the nation was making a modest start. In 1835 Cyrus McCormick secured a patent for the mechanical reaper and from that day man began to be released from the literal fulfillment of the obligation to eat bread in the sweat of his face.

The introduction of agricultural machinery was gradual until the Civil War drew from the fields hundreds of thousands of laborers at the same time that it enhanced demands for food for men and animals. The western states of the North, already the principal granary of the nation, girded themselves for their new task and with the aid of machinery raised larger crops with fewer men. From that time until the very latest modern improvement the manufacture of agricultural machinery has been a steadily growing industry and one which provided an outlet for a constantly increasing amount of the products of the steel mills.

In the industrial expansion which followed the close of the Civil War the iron industry had an important share, but by this time the cast iron and wrought iron made in the early mills were gradually being superseded by steel.

It is difficult to formulate an exact definition of steel or to point out the precise line by which it is separated from iron. In general it may be described as iron which has been cleansed of impurities and hardened and toughened by the addition of one or more alloys. Steel for the manufacture of swords and knives and axes and gun-barrels had been manufactured in small quantities for a long time. Its production cheaply and

on a large scale is due mainly to two epoch-making discoveries: the Bessemer process of making steel by forcing a blast of cold air through molten iron, and the Open Hearth process in which the melted metal is raised to high temperature by flames of burning gas blown into the furnace.

The first Bessemer steel in the United States was made in 1864, and the first steel rails made commercially were rolled as already stated by the Cambria Iron Company at Johnstown, Pennsylvania, in 1867, from ingots produced at the works of the Pennsylvania Steel Company at Steelton, Pennsylvania. Both of these companies are now parts of the Bethlehem Steel Company.

The first Open Hearth steel in the United States was produced in 1868 in the plant of the New Jersey Steel & Iron Company at Trenton, New Jersey.

Upon these two processes the later development of the steel industry is based, but the processes themselves would have been impossible but for the changes that have been made in the use of fuel.

We have seen that in England iron was first smelted by the use of wood. With the invention of the blast furnace, coal came into use as fuel and as early as 1619 an experimentally-minded English manufacturer used charred or partly burned coal in the blast furnace, thus anticipating by more than a century the general use of coke.

Iron makers in early America had no incentive to save wood, and therefore the use of charcoal in furnaces was practically universal until well into the nineteenth century. In 1812, however, some iron was being smelted by the use of anthracite coal, and by 1840, six furnaces in Pennsylvania used anthracite exclusively. In 1860 twice as much iron was produced in furnaces using anthracite fuel as was produced in charcoal furnaces. Anthracite gradually was supplanted by coke, which was found cheaper and more effective and which for many years had been in general use in England. Coke making itself underwent a revolution with the development of the by-product process in which the tar and gas driven off from the coal are collected and utilized.

Under the influence of the factors that have been briefly out-

lined, as well as many others for discussion of which space is lacking, the iron and steel industry went forward in giant strides. The World War laid upon American steel producers a task vital to the success of the allied cause and to the accomplishment of which they bent their every effort.

No consideration of the development of steel can be had without reflecting on the pioneers responsible for its growth, because it is essentially an industry the success of which has depended upon that driving force, that genius for organization, that spirit for adventure, which so profoundly characterized Americans at the time the nation was on the threshold of a rising industrial growth. In the very early days of the industry there were men who have come down to us only as names and of whom we know almost nothing but who nevertheless showed the true pioneer spirit and laid the indispensable foundations for the growth of the industry. These men were succeeded in the early '70's, when steel began to assume really impressive magnitude, by a group of industrial giants to whom the industry owes much of its present importance and prosperity. These men were well known to many of us who are still in the industry. Carnegie, Frick, Phipps—these are names that stand for achievements, and the influence of these men has been a powerful stimulant to American industrial advancement. Many others were associated with them in making the steel business of their day the worthy forerunner of the enlarged and expanded industry of the present.

The best known of all of the pioneers was Carnegie. His life is a record of achievement which fires our imagination and which has been an inspiration to hundreds of his associates. I cannot better express my own recollections of Carnegie as a business man and as a friend than I did in an address at his memorial service at Pittsburgh on November 25, 1919, when I said in part:

> Mr. Carnegie was an illuminating example of what strong personality will do in the world—of what loving personality, interesting personality, will do.
>
> Never before, perhaps, in the history of industry, have you known a man who, not himself understanding the business in its

working details, making no pretense of being a technical steel manufacturer or a special engineer, was yet able to build up such a great and wonderfully successful enterprise as Mr. Carnegie did.

It was not because he was a skilled chemist or a skilled mechanic, a skilled engineer or a skilled metallurgist; it was because he had the faculty of enlisting the people who were skilled in those arts. And while it may be an easy thing to enlist the interest of such men in an enterprise, it is quite a different thing to get their best efforts and loyal support.

And in that Mr. Carnegie was paramount over all men that I have ever known.

I wonder how many of you have ever reflected that these tremendous results which Mr. Carnegie secured were always obtained through a spirit of approval and never of criticism? Mr. Carnegie was always one to take you by the hand and encourage and approve. It was the rarest thing in the world to hear him criticize the actions of others, especially in a business sense.

I wonder if you reflect how you yourselves—how every other man responds with his best efforts under such conditions?

In my wide association in life, meeting with many and great men in various parts of the world, I have yet to find the man, however great or exalted his station, who did not do better work and put forth greater effort under a spirit of approval than he would ever do under a spirit of criticism.

Now, Mr. Carnegie understood this great thing early in life, and it was this fine philosophy, which he practised always, that made him a great commercial success.

That was one of the personal traits that made him great. I have seen him often in times of stress and disappointment, but he was always encouraging.

To illustrate that, I am going to relate a little incident that occurred many years ago, when I was manager of the Braddock works. . . . It was at a time when money was not too plentiful in the Carnegie Company, and I had asked permission to put up a new converting mill, and it had been built. It was everything I expected it to be, everything I promised Mr. Carnegie it should be, and he came out to Braddock to see it.

As I was showing him around the works and explaining the new mill, he looked into my face and said, "Charlie, there is something wrong about this; I can see by your expression that you are disappointed. There is something wrong with this mill."

I said, "No, Mr. Carnegie, it is just exactly what I told you it would be, and we have reduced our costs to the point that I said we would. But if I had it all to do over again, there is one thing which has just recently been discovered that I would introduce here, and that I am sure would result in further economy."

He said, "Well, what does that mean? Can you change this work?"

I said, "No; it would mean tearing this down and rebuilding it."

"Why," he said, "then that's the right thing to do; it's only a fool that will not profit by anything that may have been overlooked and discovered after the work is done. Tear it down and do it over again."

And although that converting mill had been running only two months, we did tear it down and we did build it over again, and the return upon the capital thus expended repaid the great firm manyfold.

Another phase of his character was thoroughness, and that may be illustrated in a way which shows how his mind worked all around a subject. In those golden days when, perhaps, we had made a profit statement which showed that the firm had made five or six hundred thousand dollars in a month, or possibly more, and I would go to him with pride and say, "Mr. Carnegie, we have made five hundred thousand dollars this month," it would not be a spirit of gratification alone that he manifested, but he would say, "Show me your cost sheets. It is more interesting to know how cheaply and how well you have done this thing than how much money you have made, because the one is a temporary result, due possibly to special conditions of trade, but the other means a permanency that will go on with the works as long as they last."

In his book entitled "The Age of Big Business," published by the Yale University Press in 1919, the brilliant writer, Burton J. Hendrick, shows a keen appreciation of the business qualities which made Carnegie a leader in the industry. Mr. Hendrick paints a vivid picture of Carnegie's early struggles with poverty when after leaving his home in Scotland as a child he found himself at the age of thirteen "living in a miserable hut in Allegheny earning $1.20 a week as bobbin boy in a cotton mill, while his mother augmented the family

income by taking in washing." Of the men prominent in the steel industry in the early '70's, Mr. Hendrick said:

> The Pittsburgh group comprised about forty men, most of whom retired as millionaires, though their names for the most part signify little to the present-day American. Kloman, Coleman, McCandless, Shinn, Stewart, Jones, Vandervoort—are all important men in the history of American steel. Thomas A. Scott and J. Edgar Thompson, men associated chiefly with the creation of the Pennsylvania Railroad, also made their contributions. But three or four men towered so preëminently above their associates that to-day when we think of the human agencies that constructed this mighty edifice, the names that insistently come to mind are those of Carnegie, Phipps, Frick, and Schwab.

The work of the pioneers in steel is being carried on to-day by worthy successors. But these new leaders—Farrell, Grace, Campbell, Topping and the others—are facing new problems created by changes in the industry and our economic life. These problems have to do principally with the broadening relationships among four classes of people: the employees, the investors, the customers and the general public.

While there are still and always will be problems of building, expansion and invention, the new leadership calls less for the qualities of the pioneer and the explorer and more for those of the administrator and negotiator—the man with broad understanding of all aspects of his business and its interdependence with other industries.

The growth and concentration of modern industry have enormously increased the mutual responsibility and mutual interest existing between business and the public. In this development the steel industry has had a large share. The new leadership in the steel business recognizes this close relationship and accepts the obligations which it imposes. Enlightened public opinion likewise understands the fundamental connection between business and public welfare. The large numbers of employees and stockholders, the inter-dependence of all industries, and the economic social and political effects of business policies and of industrial success or failure have brought about a situation in which business and the public need to understand each

other's interests. Consideration of these facts has brought about important changes in the relations between the steel industry and the public which it serves.

There has been a growth of confidence between the industry and the community; each has come to see things somewhat from the other's viewpoint. In common with other large industries the steel business has adopted the policy of giving facts frankly to the public, taking the mystery out of business and dealing openly in matters which concern its affairs. This growth of confidence between the industry and the public is perhaps best typified by the organization and growth of the American Iron and Steel Institute, which for over seventy years has not only furnished a forum advancing the scientific and technical improvement of the industry, but has also formulated and crystallized the best ideals of its leaders for the public good. It has also furnished a channel through which all of the economic facts concerning the industry have been made available to the public at large. No statement of the accomplishments of this great institution in American business life would be complete without mention of the monumental work in its behalf by the late Judge Gary, its president for many years. The extent to which the consumers have participated in the gains of the steel industry through efficiencies, economies and increased capital investment has already been discussed.

No consideration of the progress of the steel industry would be complete without mention of that fine body of stalwart, virile workmen who by their creative craftsmanship have so ably performed the tasks required to make steel. Work in a steel plant requires real effort and ability but it has its fascinations and opportunities as well.

The wage-earners in the steel industry are now receiving annually over two and one-half billion dollars in earnings. In 1901 the average rate of wages for unskilled labor was fifteen cents per hour in the steel mills; and the annual earnings for all steel workers averaged $825. This rate had trebled by 1926 to forty-four cents per hour, but the worker was putting in 18 per cent. less time, the twelve-hour day having been eliminated in 1923. In 1926 earnings for all labor averaged $1,870,

an increase of 127 per cent. since 1901. Living costs have gone up 68 per cent. since 1913, at which time they had remained at about the same level for quite a few years. The workman therefore is now better off financially than he ever was before.

According to statistics compiled by the National Industrial Conference Board the average weekly wages paid in the steel industry in 1926 exceeded those paid in any other of twenty major manufacturing industries, and are approximately 30 per cent. above the average of the entire group.

The steel industry is strongly committed to the policy of paying by results. It is fundamental in human beings that they want individual recognition and reward for their talents and achievements. The steel industry recognizes that this is the crux of the wage problem and that the nearer it can come to fulfilling this want on a sound, equitable basis that recognizes individual merit, the sooner it will witness the solving of all the problems relative to wage payment.

We have come to have a new viewpoint toward the payment of wages. Our better relationships have brought a clearer understanding of the reciprocal value to national well-being of a class of well-paid workers whose buying power is sufficient to take the output of our mass production. The economic position of our workers has become the wonder of the world. The earnings of American wage-earners in terms of what they can buy are probably greater now than at any previous period in American history; certainly they are far greater than those of the working men of any other country of the world.

The necessity to-day for the high purchasing power of labor referred to becomes more significant in view of the fact that industry is organized on a mass-production basis and this naturally requires mass buying. Perhaps this is one of the most important trends in the economics of the labor situation, and in every labor policy this element is basic. The ability to buy by the greatest number is of uppermost concern to the entire business world.

Our industries have ceased to function solely or mainly to supply the needs of the wealthy classes. These needs would not be sufficient to require even a fraction of our present pro-

ductive capacity. It is therefore imperative to have a high and sustained buying power by the masses of the people, including the producers themselves, and the steel industry is making its contribution through the high wages which it pays. These high wages coupled with the decline in living costs over the last few years have been a most powerful factor in extending the markets and increasing the standard of living of workers.

One of the ways in which the steel industry has been able to maintain high-wage rates and support the purchasing power of labor has been through the adoption of scientific methods of payroll administration. In the past the steel industry relied largely upon an unlimited supply of immigrant labor for its heavier and less agreeable tasks. This source has now mainly been shut off through restriction of immigration and yet there is an ample supply of labor.

Broadly speaking, the reason for the adequate supply of labor in spite of immigration restriction is increased productivity. This increased productivity has had its greatest growth during the last five or six years. It has been brought about by three outstanding developments: first, by capital expenditures through which mechanical devices, electrification, larger units, changed methods and processes have been extended; second, by improved management; third, by increased efficiency on the part of labor itself. With this increased output per man and with the prospect that further technical improvements may cut down still more the requirements for individual effort, management in the steel industry has been faced with the problem of how best to fortify the buying power of labor by maintaining high wage levels and meeting the needs for reducing manufacturing costs. Toward the solution of this problem the industry is conscientiously applying itself in the interest of its employees and the prosperity of the country.

The great change which has accrued in the relations between management and men in the last decade has given the worker a new sphere of influence, partnership and coöperation in industry, so that his position to-day as a citizen and as an employee is beyond comparison with any other time in history. The new position of the employee in industry constitutes one

of the most significant and wholesome developments of the last one hundred years. Steel has brought together and welded into single organizations thousands of human beings with widely different habits of life and thought. At the same time this brought about the need for methods of treatment that would humanize our industry and make the men in it substantial self-respecting workmen and citizens and factors coöperating in the success of the business.

Toward the development of these better relationships the Employee Representation Plan has been a powerful aid. Successful human relations in industry recognize that the interests of employees and employers are mutual. It is recognized that as enemies they cannot long endure; they must be friends. The very nature of their aim for profit creates an interest in one another's well-being.

It is true that just as in any human relationships there are day by day problems arising in industrial relations which if not settled with full justice to each will threaten this bond of friendship. But the need for a medium for preventing or adjusting breaches in relations is not the whole objective of employees and employers. Essentially these two parties have been seeking a medium that would provide a common meeting ground. They have really been seeking for a way of living together which would permit an expression of their personality and yet cement and increase this friendship. The employee representation movement is such a constructive medium, permitting not only settlement of questions on which there is a conflict of interest, but of even more importance offering an unobstructed channel through which their unity of interest may be promoted.

As an example of what this means in the practical operation of the steel industry, the Bethlehem Steel Corporation plan of employee representation may be cited, and the regard which Bethlehem has for the human factors is typical of the attitude of the industry as a whole toward those engaged in it. The plan, originally a mechanism for the adjustment of grievances, has evolved into a phase of constructive coöperation with management.

On the one hand the employees have gained a more intimate knowledge of their company and its objectives, and, on the other hand, the supervisors have come to realize more definitely than before their function as leaders rather than as drivers of men.

Even with the better relations established through high wages and means of constructive coöperation, the working man is likely to lack one factor essential to his fullest efficiency and greatest interest in the company by which he is employed—this factor is ownership. A sense of proprietorship affords a powerful incentive to arouse interest in the performance of work. This principle has been the motivating influence of those who have been willing to take the risk incident to the building of all business. Its application to the wage-earner in industry is relatively new, yet nowhere is the whole-hearted interest of human beings so necessary and vital to successful accomplishment. Recent years have seen a considerable growth in stock ownership by industrial employees. Steel corporations have been among the leaders in adopting the practice of encouraging ownership of their stock by employees, and to-day a large number of the employees of the steel industry have an interest in their company as owners as well as workers.

The steel industry early recognized the necessity for safeguarding the lives and health of its workers, and in this respect has pioneered, thereby making a contribution to the welfare of its employees and their families.

The extent to which both sickness and accident affect both wages and stability of employment makes any corrective measures that can be adopted of the most vital concern. For a number of years advances in safeguarding the lives of its workers have been a noteworthy achievement on the part of the steel industry, and this good work is steadily going forward under the whole-hearted inspiration of the industry's leaders.

Other important aspects of industrial relations in which the steel industry has been active include old-age pensions, disability and death benefits and educational work of varied kinds.

With these improvements in the relationships between management and employees, and the increased coöperation and

efficiency which they have brought about, the future of the steel industry is bright, especially as there is no reason to doubt that the general prosperity of the United States will continue. It is safe to assert, therefore, that steel will continue, as in the past, to contribute powerfully to the growth and development of American civilization.

VII

MACHINERY AND POWER

By Dexter S. Kimball

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THE most significant phenomenon of recent times has been the rise of the United States to a dominating position industrially and financially. The first census taken in 1850 gives the per capita wealth of this country as $383; the latest records indicate that our natural wealth is approaching $400,-000,000,000, which indicates a per capita wealth approaching $4,000 and the national income is now approaching $90,000,-000,000. Whence comes this enormous accumulation of the good things of life which, incidentally, have been more widely distributed than in any other period of man's occupancy of this planet. It is not uncommon to ascribe our industrial success to our vast material resources. No doubt this is a great contributing factor but it should be noted that our forerunners, the Indians, had undisputed possession of these same resources. No doubt, also, there are many reasons for our prosperity but there are three lines of development that are outstanding and which have affected our industrial growth more than any other influences. These are the development of modern machine tools, the development of power-producing machinery, and the development of ways and means of transmitting intelligence through the telegraph, telephone and the radio. The first two of these are basic developments and the third has greatly increased the efficiency of the first two by speeding up, so to speak, the great industrial machinery of modern times. This article deals with the first two, a discussion of the third belonging elsewhere.

The problem of tools is as old as man himself. Yet strange

as it may appear the progress he had made in developing tools up to the end of the eighteenth century is meager indeed when compared with the progress of the last one hundred years. The ordinary hand tools then in common use were primitive enough, but the tools *for making tools* were even more crude and primitive. The invention of the steam engine in England near the end of that century and the introduction of more advanced machinery in the textile industries gave a great impetus to the construction of basic metal-working machines and there appeared in that country the first of these basic tools now commonly known as "machine tools" in the shape of an improved form of lathe for "turning" circular pieces. This was followed by the development of the planing machine, improved forms of drilling machines and the boring mill, a derivative of the lathe. From these early and crude tools there has been developed the vast array of machine tools that fill our machine shops and which have very appropriately been named "The Master Tools of Industry." Upon these tools depend the construction of all other kinds of machinery and the size and accuracy of all modern machinery depend upon the size and accuracy of the machine tools available for their construction. And the contribution of this country to the development of these basic tools is worthy of more than passing attention.

The most important contributions of American tool makers to these basic machines are probably the milling machine, the turret lathe, the automatic lathe and the grinding machine. The first successful milling machine was the invention of Eli Whitney and is now in the possession of Yale University. The development of the turret lathe is credited to Henry D. Stone at Hartford, Connecticut, and the full automatic lathe to Christopher Miner Spencer also at Hartford. The drop hammer is also of American origin. So that while in all fairness the credit for originating machine tools belongs to our English forbears, the contribution of the American mechanic during the past one hundred years is noteworthy.

The development of machine tools has progressed along three lines, namely, increase in size, increase in accuracy and a marked tendency toward the more extended use of semi-auto-

matic and automatic machinery in what is known as "interchangeable manufacturing" or "mass production" which will be discussed later on. The growth in size of these basic tools during the last century is most remarkable. The original lathe of Maudslay, constructed in 1800, and the milling machine of Whitney, made about 1818, could be carried around by one man. To-day, lathes that will machine cylindrical surfaces up to fourteen feet in diameter, planing machines that will handle work sixteen feet wide and boring mills that will turn and bore work up to thirty-six feet in diameter are advertised as regular product by leading American tool makers. Much larger tools are found in special industries as for instance the great boring mill of the General Electric Company which can handle circular pieces up to sixty feet in diameter. All other forms of machine tools have increased in size in like proportion and these would appear to be no reason why much larger tools cannot be constructed if necessary; and when it is considered that the size of all industrial equipment depends upon the size of such basic tools one is led to wonder what the ultimate proportions of our industrial equipment will be. And the great growth in size of these basic machines should be kept in mind in considering the development of all other kinds of machinery. For, after all, the marvelous thing is not the size of these industrial machines but rather the size of the tools on which they are created and the possibilities that the future may hold for even greater undertakings.

Of course there has been progress along other lines. There has been great advances in our knowledge of the properties of materials and the methods of working them. The Bessemer process and the open-hearth process of making steel and improvements in methods of working metals have all contributed. And the application of advanced scientific methods to the design of machinery and structures has given designers a background of recorded experience that makes the design of great machines less of a problem even than that of their predecessors of one hundred years ago who had little science and who had to depend almost wholly upon experience and empiric rules.

Any account of the many kinds of machinery that make modern industry what it is lies beyond the scope of this article. And any account of the brilliant work of the many American machine-tool builders who have made this development possible necessitates equally a much longer discussion than is here possible.

Progress in the accuracy with which machinery is constructed has come through the development of more accurate measuring instruments and the development of machinery for grinding finished surfaces instead of finishing them by cutting tools in such machines as the lathe and the planing machine. The first great improvement in measuring mechanisms was the introduction of the micrometer which while a French invention owes its development to the pioneer firm of tool makers Brown and Sharpe of Providence. This firm was also one of the first in this country to make a measuring machine of great accuracy that could measure to the one hundred thousandth of an inch. To-day there are upon the market standard reference gauges that are accurate to the one millionth of an inch. The process of producing these blocks is complex, involving the use of refined grinding methods and of the length of light waves for measuring purposes. Such standard gauge blocks are used as references in making the working gauges that are actually used in manufacturing.

The use of grinding wheels as a method of finishing surfaces requiring great accuracy of form was begun by Brown and Sharpe in the early sixties of the last century. For many years such machines were used almost wholly for tool making and similar refined operations. To-day grinding is the approved method of finishing all surfaces requiring great accuracy even in the case of machinery of large size. Grinding methods have made it possible to produce surfaces by machine methods that are far more accurate and exact than can be produced by handwork so that, except in certain special cases, the machine-made product of to-day is more accurate than the hand-made product. A hand-made watch could not compare in accuracy with the modern machine-made product, though a few years ago the

contrary opinion was held by most people and indeed is still held by the few who do not understand the extreme accuracy of modern machine tools.

As has been noted, the turret lathe and the full automatic lathe are distinctly American in their origin and development. They are the most important tools of the semi-automatic and full automatic type that are used in general machinery manufacturing where quantity production is possible. Like all such tools they have grown in size and capacity, some modern turret lathes working bar stock up to six inches in diameter and some automatic lathes operating several spindles and cutting tools simultaneously, thus greatly increasing their capacity.

Of equal importance has been the extended use of the principles underlying the semi-automatic and the automatic lathe to manufacturing operations other than metal working. They have been applied to all manner of productive processes and in most unexpected callings. Much of the machinery used, for instance, in the canning of salmon on the North Pacific Coast is of a highly developed automatic character and the tendency in all American industry is to extend the use of machinery in all manner of industrial work.

Without doubt, however, the greatest contribution that this country has made to modern productive processes is that method of production commonly known as *interchangeable manufacturing* sometimes called *mass production* and known abroad as the *American system of manufacturing.* While these methods are distinctly American in their development, it is known that unsuccessful attempts to produce interchangeable parts were made in France as early as 1715. Interchangeable manufacturing consists essentially of making all similar parts so close to a given standard as to be interchangeable; that is so that any given part of the machine can be removed and any one of similar manufactured parts put into its place. Also, it means that all parts of a given machine are manufactured so closely to a given standard that the machine may be assembled without handwork or individual fitting of any part. Necessarily, therefore, such a system of production must rest upon accurate basic standards of measurement and gauges and manu-

facturing machinery and tools of great precision. It first came into use in this country about 1800 when Eli Whitney manufactured a large number of muskets for the United States Government upon the interchangeable plan. These methods once successfully demonstrated soon spread to watch and clock making and when the sewing machine appeared in 1846 these mass production methods were at once applied to it and they are largely responsible for the widespread use of this epoch-making invention. To-day in this country these methods are applied universally to the production of watches, clocks, typewriters, automobiles, clothes and the myriad manufactured goods, useful and useless, that fill our houses and cater to our comfort and pleasure, and which have been brought within the reach, financially, of millions of people who but for these new and highly efficient methods could take no part in their production nor enjoyment in their use. The most important machines in mass production are the turret lathe, the automatic lathe, and the milling machine, and it is an astonishing consideration that such great productive results could flow from such comparatively simple inventions. There can be little doubt but that our great wealth is due in no small measure to the development of these modern tools, and the machinery that has made them possible. When it is considered that this entire development is little more than a century old one is led to speculate what the succeeding century will bring forth. It does not seem possible that the same rate of progress can be maintained, yet in the light of past performances and present-day growth he would be a hardy man who would make any prophecies. The results already obtained are highly significant.

For it should be remembered that scientific discovery and mechanical invention of themselves may signify little unless their potential benefits can be widely used. The United States has been blessed with many men of highly inventive minds as illustrated by such basic inventions as the sewing machine, the harvester, the typewriter, the cotton gin, the telegraph, the telephone, the radio and many others. But the widespread use and consequent benefits that flow from these inventions have been made possible only through the use of the productive methods

that have been described supported by the abundant use of power. And the outstanding achievement of the combination of the use of mass production methods and power is found in the automobile. At the present moment the people of this country own an automobile for every five persons. Thus if at a given time every owner of an automobile should fill his car to capacity the entire population of this country could go for a ride in a machine that a few hundred years ago would have been looked upon as the work of magic and whose builder would most probably have been hanged or burned as being in league with the Devil. Surely this is a wonderful age, but there is reason to believe that in a few years we shall all be able to navigate the air as freely as we now traverse the land.

As was noted the United States has been blessed with many great inventions. To tell even briefly of this long list of benefactors would exceed the limits of this article. The story of Eli Whitney and his cotton gin for cleaning cotton, of Elias Howe and his sewing machine, of Cyrus McCormick and his reaper, of Ottmar Mergenthaler and his linotype, of George Westinghouse and his air-brake, of George Pullman and his sleeping car, of Henry Ford and his automobile and many others, with the fascinating and often pathetic account of their successes and trials, is the story of American invention. And each one of the long list is deserving of a book in itself.

Man's greatest need in subduing his environment next to that of tools has been that of mechanical power. From earliest times he has tried to supplement his puny physical strength by calling to his aid the wind, waterfalls and tides. The invention of the steam engine in the latter part of the eighteenth century for the first time gave him hope of an abundant supply of power for operating his tools of industry. Subsequent improvements in the steam engine and the steam boiler, the development of the steam turbine and the internal combustion engine and the use of the electric current as a means of distributing and applying power have been the most important influences in the development of modern industrial life.

Americans can claim little or no credit for the invention of these so-called "prime movers." The steam engine was in-

vented by Watt in England, and the gas engine, the Diesel oil engine and the steam turbine also had their beginnings on the other side of the Atlantic. American engineers, however, have made a considerable contribution to the development and application of these machines both as to efficiency and size, some of the latest developments in this line on this side of the ocean being unparalleled. The application of steam to navigation by Fulton was one of the monumental contributions by American engineers.

One hundred years ago the steam engine was a comparatively simple machine using steam pressures rarely as high as one hundred pounds per square inch. The steam was admitted to the cylinder by simple slide valves or poppet valves. In marine work compound engines were at work and the economies due to proper expansion of the steam before exhausting it were beginning to be well understood. Governing of the speed of rotation was accomplished by a "throttling governor" which regulated the supply of steam through the steam pipe which supplied the engine. The valve which admits and releases the steam was attached permanently to the valve gear which operates it.

The first important improvement to the steam engine was the invention of the "drop-cut-off" or "detachable valve-gear" by Frederick E. Sickles about 1841. In this device the valve is detached at the proper moment and closed quickly in advance of the driving mechanism, thus giving a quick "cut-off" and better steam expansion. In 1849 George Corliss, another American inventor, connected the governor to the drop-cut-off gear so that the time of cutting off the steam was very accurately timed. He also improved the construction of the valves themselves and the "Corliss" engine long remained both in this country and abroad the finest type of steam engine. For the Centennial Exposition of 1876 at Philadelphia Corliss built a two-cylinder engine of fourteen hundred horsepower which was considered to be a phenomenally large engine and did much to promote the use of his inventions in this country and abroad. With the development of electricity as a means of distributing and applying power larger and larger Corliss engines were built

until "cross-compound" engines of this type of four thousand horsepower were developed. In the largest of these installations two such engines were used, one on each end of the shaft, thus applying eight thousand horsepower to the generator mounted upon the shaft between them. In fairness it should be noted that McIntosh and Seymour, using a different kind of valve gear, also built some engines of the same size. And it was the problem of building the great generators driven by these huge engines and which were thirty feet or more in diameter that necessitated the construction of the very large machine tools already described. The last of these great Corliss engines were erected near the beginning of this century.

The Corliss engine and other engines using "detachable" valve gears were necessarily operated at a low speed but the advent of the electric generator made higher speed very desirable in order to avoid the excessive dimensions of the generator noted in the foregoing. This gave rise to the so-called "high-speed" engine in which the valve is permanently attached to the valve gear and governing is accomplished by a powerful "shaft-governor" which controls the point of cut-off and consequent ratio of expansion of the steam. The pioneer in the development of the high-speed engine was Charles T. Porter. But there were many other American inventors who made basic contributions to the development of the high-speed engine and the names of Allen, Sweet, Thompson and Carpenter and others are indissolubly connected with this development which is largely American.

In the meantime a Swedish inventor, Gustav Laval, had been experimenting with an old idea and had built in 1882 a successful *impact* steam turbine. While successful practically it ran at very high speed and had to be "geared down." In England Charles A. Parsons in 1887 brought out the first successful *large* steam turbine and ushered in a new era in steam power. One of his turbines was brought to the United States by the Westinghouse Electric and Manufacturing Company and formed the basis of the development of the turbine by that company. This machine is now in the possession of Cornell University. The greatest contribution by Americans to the art

of turbine design was that of Charles E. Curtis whose patents were acquired by the General Electric Company and formed the basis of the development of the turbine by that company. The greatest development of this prime mover has been in connection with the driving of electric generators though a few companies build them for other purposes and they have become widely used for marine propulsion.

The size of some of these turbo-generators is almost unbelievable. For instance, the first successful turbo-generator installed by the General Electric Company for the Chicago Edison Company in 1903 was of 5,000 kilowatt capacity. To-day turbo-generators of 50,000 kilowatt are quite common, the Trenton Channel power house of the Detroit Edison Company having six such machines. A few turbo-generators of 75,000 kilowatt are in operation and there are now being constructed two sets of 90,000 kilowatts each, one of 104,000 kilowatts and one of 208,000 kilowatts. This last and greatest machine, which will be built by the General Electric Company for the State Line Station at Chicago, will generate current at 18,000 volts at the machine. It will weigh about 41,000,000 pounds, the heaviest single part weighing 275,000 pounds. It will be supplied with steam at 600 pounds per square inch, will require two tons of coal per minute to keep it going and will require 400,000 gallons of condensing water per minute. No such prime movers as these have ever been built or attempted elsewhere.

Naturally other features of power house construction have grown in like proportion. Space will not permit a description of the growth in size and efficiency of boilers, condensers, etc. The use of oil as a fuel has become quite common. Large boilers are fired by automatic stokers which not only increase the efficiency of combustion, but also greatly reduce the smoke produced. Most interesting of all developments in this line is the introduction of powdered coal as a combustible. In this method the coal is crushed and ground to a very fine powder and blown into the furnace by an air jet giving practically perfect combustion. This method of firing is well past the experimental stage. The rise in steam pressure should also be noted.

A plant of three thousand kilowatts has been successfully operated at twelve hundred pounds per square inch and, as noted in the foregoing, six hundred pounds is no longer considered hazardous in large plants. The efficiency of the combined steam engine and boiler have also been greatly increased. The early engines were necessarily very inefficient but steady improvement had reduced the coal consumption to two or three pounds of coal per horsepower per hour for good engines some time ago. The great power houses described in the foregoing are now approaching a performance of one pound of coal per horsepower per hour and this may be still farther reduced with increased size, higher pressures and improved machinery. Lastly, the growth in the capacity of power houses should be noted. Power plants of 200,000 and 300,000 kilowatt capacity are now quite common and there are a few of greater capacity. Looking into the near future, however, some of these great reservoirs of energy are being planned to supply as high as 1,000,000 kilowatts. The maximum size that generators may reach and the maximum total capacity that will eventually be concentrated in a single power plant offers an interesting speculation for, as will be shown, these developments are exponents of our ultimate level of existence.

While the modern steam engine was thus taking form the gas engine was also slowly developing. The gas engine differs fundamentally from the steam engine in that while the fuel for the steam engine is burned *externally,* the fuel for the gas engine is burned *internally.* It is therefore sometimes called an *internal combustion motor.* Gas and air are drawn into the working cylinder, compressed and ignited, the succeeding explosion driving the working piston. In the gasoline engine the gasoline is first evaporated by means of a *carburetor* and then worked in the cylinder like any other form of gas. In this form the gas engine is most familiarly known in connection with the automobile. The principle of the gas engine had long been known, but it was not until 1867 that Nicholas Otto, a German engineer, built a successful gas engine. For the most part the gas engine has been built in small sizes, only, in this country its convenience of operation recommending it for small

powers. However, in such work as smelting, where a large volume of combustible gas is available, gas engines of very large dimensions have been built.

The most important development in the internal combustion motor in recent years was the invention by the German engineer, Rudolph Diesel, of the engine which is known by his name—the Diesel engine. While the principle of its operation is simple, the actual development was beset with many difficult mechanical problems. When air is compressed it becomes heated and if compressed to three hundred or four hundred pounds per square inch it becomes hot enough to ignite even heavy fuels such as fuel oil and similar heavy liquid compounds that are combustible. In the Diesel engine air is highly compressed by the working piston as it moves away from the crank. When it reaches the end of the stroke fuel oil is injected into the heated air, burning as the piston starts outward and thus raising the pressure and driving the piston forward. The theoretical and practical efficiency of the Diesel engine is considerably higher than that of the steam engine and it requires no boiler as an auxiliary. The engine itself is much heavier than a steam engine of the same power and as yet it is not so reliable in operation. Nevertheless it is rapidly coming into extended use in this country, especially where oil is cheaper than coal. In marine work it appears to be supplanting the steam engine for freight service. As yet it has not been built in sizes larger than two thousand horsepower in a single cylinder. Marine and stationary engines with six cylinders of five hundred horsepower each are now built in this country with decided success.

Diesel himself believed that solid fuels could also be ignited into the cylinder with success, but did not live to demonstrate the possibility himself. In view of the probable short life of our fuel oil deposits and the success already attained in burning powdered coal externally it is not too much to expect that Diesel's theoretical expectations in this regard may yet be realized practically.

Another interesting prime mover that is still in the experimental stage is the *gas turbine;* that is a turbine driven directly

by gas acting upon the blades in the same way that steam is now used. So far no practical results of merit have been attained, but looking backward upon the history of the steam engine, the gas engine and particularly the Diesel engine there is reason to hope that this problem may be solved. A most interesting development along these lines is the mercury vapor engine invented by the American engineer, William L. Emmet. In this engine mercury is evaporated in a boiler, thus producing a vapor at low pressure, but high temperature. This vapor is passed through a turbine thus producing mechanical power, the vapor is condensed and returned to the boiler. Now the *efficiency* of heat engines depends upon the temperature of the working medium rather than upon the pressure used. One of the difficulties of the steam engine is that high temperatures are accompanied by high pressures, thus bringing serious mechanical problems into action. Engines using the Emmet cycle have been successfully operated and future experimentation along this line will be watched with interest.

Two applications of the steam engine have received the earnest attention of American engineers, namely, the locomotive and the marine engine. American engineers began to build locomotives immediately after the classic work of Stephenson, the famous DeWitt Clinton now on exhibition at the Grand Central Terminal in New York and still in working order being built in 1831. The story of the development of the locomotive in this country is beyond the scope of this article. But it should be noted that the vast size of this country and the great amount of freight to be moved have made it necessary to develop locomotives much larger and more powerful than are to be found elsewhere. The DeWitt Clinton weighed three and one-half tons, while a first-class freight locomotive of the largest size to-day weighs one hundred times that amount and locomotives have been constructed for very heavy freight service that weigh over four hundred tons and have a tractive effort of one hundred and sixty thousand pounds. No such locomotives have been built elsewhere and the giant machines of the Mallet compound type with two complete sets of engines and driving wheels must really be seen to be appreciated. Yet in spite of

their great size they and the great loads they draw are handled much more easily and accurately than were their pigmy predecessors, for the air brakes, the invention of an American engineer, George Westinghouse, and developed entirely in this country, have made modern railroading the astonishing success that it is.

In the powering of ships American engineers have not only kept up with progress but have made contributions to progress as well. This is particularly true in naval construction and the performance of the machinery of the battleship "Oregon" during the Spanish War is still quoted as a record achievement. Perhaps the most noteworthy contribution of American engineers to marine engineering of recent times is the electric drive as applied to large vessels. The usual method of driving a ship is to couple the engine directly to the propeller shaft. In the case of the old reciprocating steam engine which had a wide range of speed and which could be reversed in motion readily this made a very flexible arrangement. The turbine is not a reversible machine so that an auxiliary reversing turbine must be used. The Diesel engine can be reversed but not so readily as the steam engine. Mr. William L. Emmet is responsible largely for the introduction of the electric drive for large ships and the first battleship to be so equipped was the "California" of the U. S. Navy. In this ship steam turbines drive direct-connected electric generators as in any stationary power house. On the inboard end of each propeller shaft there is coupled an electric motor which can be actuated in either direction by current from the generators. Electric control thus takes the place of the ordinary mechanical control as when the engine is directly connected to the shaft. Now electrical control is very flexible and easy to manipulate. Furthermore the controlling switches can be placed at any convenient place and do not need to be near either engine or motor and as a consequence the ship may be controlled entirely from the pilot house if desired, and this method is coming into wide use for some services. It is particularly convenient for Diesel motor-driven ships, for, as before stated, the Diesel motor does not reverse as readily as the old steam engine. The Southern Pacific Rail-

road Company has just put several large ferry boats into operation on San Francisco Bay that have Diesel-electric drives controlled from the pilot house. It will be noted also that with such an arrangement a number of engines either steam or Diesel can be installed in the engine room instead of a single large engine, thus giving more flexibility and insurance against breakdowns. This plan therefore opens a way for the use of Diesel engines in very large vessels since at present there are limitations to the size of such prime movers. The Diesel-electric drive is also being applied with success to locomotives. In Switzerland this practice is quite advanced, but in the United States, where coal is plentiful, it is still in an experimental stage. Small locomotives driven by gasoline engines through electric connection to the driving gear are now quite common.

Not less spectacular has been the development of one of man's oldest helpers, namely, water power. Fifty years ago the old romantic water wheel was still a feature of the New England landscape. These have given way long since to the water turbine in the development of which American engineers have occupied a prominent place. Here again the sizes attained are noteworthy. Fifty years ago the largest water turbine had a capacity of only a few hundred horsepower and an efficiency of about 70 per cent. There are now in operation at Niagara Falls three hydro-electric units of seventy thousand horsepower each with an over-all efficiency of over 90 per cent. It is estimated that each of these giant water wheels working twenty-four hours daily, which it can do if necessary, will do the work of 1,633,000 men. Working twenty-four hours a day for one year one of these machines would produce as much energy as would be produced by burning six hundred thousand tons of coal in a modern central station. Such figures are very impressive, when considering the possibility of the depletion of our fuel resources.

An equally important American development is the Pelton water wheel, so-called from the name of the inventor. This development grew out of the effort to utilize the very high hydraulic heads that were originally used on the western slopes

of the Sierra Nevada mountains in California for washing gold deposits. In principle these wheels are not unlike the old-fashioned water wheel, the water playing upon the vanes or buckets from a nozzle with great force instead of simply running into the buckets and rotating the wheel by gravity. These machines have been highly developed and are used exclusively for very high heads and moderately large quantities of water. They lend themselves admirably to direct connection to the electric generator and are much used therefore for harnessing mountain streams in inaccessible places. Some of the very earliest hydro-electric installations at high voltage employed Pelton-type wheels.

Now the development of machinery and prime movers after all is important mainly as they affect humanity through the social, economic and political developments they engender. Individual and consequent national ideals are dependent upon the degree to which we can emancipate ourselves from our environment and subdue an unfriendly and unrelenting nature. The ancient civilizations not possessing our modern equipment made a virtue of a necessity and freely and openly employed slaves to do the work necessary to support them. Ideals, both individual and national, have always been *ideals of necessity*. Great as was the development of the ancient Greek mind of the age of Pericles it yet retained a savage element as concerns the matter of slavery. We, even in this so-called enlightened age, have ideals of necessity. Yet we have freed ourselves as has no other people from the limitations and difficulties of animal existence and it may be interesting in closing to record the degree to which we have done so. It is obvious that modern machinery itself is dependent upon power both for its production and its operation, therefore the amount of power any nation possesses is a criterion of its possibilities in the direction of the thing we call modern civilization.

The potential water-power resources of the United States are estimated at thirty-four million horsepower. Dr. F. R. Low, editor of *Power*, gives the following estimate of prime-mover capacity actually installed in the United States.

Central stations and Industrial	45,000,000
Electric Railways	4,119,000
Mining	5,147,000
Stationary (non-industrial)	4,000,000
Steam railroads	130,000,000
Navigation	16,000,000
Agricultural and traction	200,000,000
Automotive	300,000,000
TOTAL	704,266,000

Mr. Low remarks: "If these figures are correct there is installed for each unit of our population prime-mover capacity equivalent to the ability to produce for each man, woman and child of our population, if they demanded it, physical service equivalent to that which could be rendered by one hundred and fifty slaves." And again he states: "To-day power-operated machinery is doing in these United States alone more work than could be performed by all the able-bodied men in the world working like slaves, from sunrise to sunset."

Mr. Thomas Read estimates that the total annual output of work by prime movers in the United States is four times as great as is produced in Great Britain or Germany and ten times as great as in France. He further remarks that "the per capita wealth in the United States bears the same ratio to the per capita wealth in Great Britain that the total per capita work here does to the work there," a result that would naturally be expected. He also states that the output of mechanical power in the United States exceeds the total output of the remainder of the civilized world. Surely here are basic developments that lie at the bottom of our industrial greatness. It is no accident that we have an automobile to every five people, nor that our per capita wealth and national income are rising steadily. Our possessions are what they are because we have produced them and machinery and power are the basic factors in this production. And it should be remembered that we are far from the end of this development. Our industrial processes are still woefully inefficient, as compared to ultimate possibilities and we still have potential sources of power undeveloped.

Most important of all is the change in our national ideals that this conquest of nature has given us. It is quite the custom to condemn this age as materialistic and uncouth. No doubt there is much basis for these criticisms. It is to be expected that the liberation of millions of people from the drudgery of long hours will result in many abuses of this new freedom. And the background and inheritance of much of our population does not make one over-optimistic as to the future of democracy. But high above all this we find a firm conviction in the minds of the majority of thoughtful men that it is possible to achieve an industrial development that will fulfill the utopian dream of many who have preceded us, the dream of *universal well-being* where there shall be food, clothing and shelter for all and for all, also, some degree of mental and spiritual development. Whatever may be the defects and dangers of modern industrialism it holds out for the first time to humanity some hope that we shall at last conquer our environment. And these difficulties and dangers are not necessarily inherent in modern industry itself. The real danger lies in our lack of ability to understand the economic and social effects of these gigantic forces we have unleashed. And if we fail to conquer our environment, or if this great experiment in democratic government should fail, it will not be for lack of patriotism or loyalty, but because we shall not be able to develop leaders competent to direct the new industrial forces or, what is more likely, we shall not have the foresight to place such leaders in governmental positions where they can make their influences felt. The next great problem in government is to bring the ability of intelligent and high-minded men who understand these industrial developments to bear upon these problems that hold out so much hope for humanity.

VIII

COTTON TEXTILE INDUSTRY

By Walker D. Hines
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WHILE this article is addressed to the developments of the century from January 1, 1828, to January 1, 1928, some comments are in order concerning antecedent conditions. Until forty years before the American Revolution (1775-1781), cotton fabrics in this country were woven on a common hand loom on which the shuttle was thrown through the web with one hand and caught with the other. This operation was repeated for every thread of the woof. Yarn was spun on a wheel with a single spindle and the cotton was prepared for spinning by laborious carding with a pair of hand cards.

During the latter half of the eighteenth century, a series of inventions and developments in England gradually transformed the manufacture of cotton textiles from a manual industry into a mechanical one. This transition was largely due to the invention of a carding cylinder by Lewis Paul in 1748, the development of spinning and carding machinery by Richard Arkwright between 1768 and 1775, Watts' invention of the steam engine in 1782, Cartwright's invention of the mechanical loom in 1785, which later became the basis of the power looms of to-day, and Bell's invention of cylinder printing in the same year. Thus shortly after the end of the American Revolution, England was in possession of all the elements of a great manufacturing industry and was prepared to extend her business as rapidly as the supply of raw materials could be furnished.

The industry's development in the colonies was far behind that which had taken place in the mother country as legislation

and a rigid colonial policy prohibited the shipment of any of the new mechanical devices made in England. The real beginning of the manufacture of textiles in the United States on a commercial scale dates from 1790, when Samuel Slater, a young English mechanic, built and operated the first successful spinning plant in Pawtucket, R. I., consisting of a waterframe of twenty-four spindles, and two carding machines with drawing and roving frames based on the Arkwright patents.

Before coming to America, Slater had served a full apprenticeship under Jedediah Strutt, a partner of Sir Richard Arkwright, had become his master's chief assistant and had supervised the erection of some new works for his employer. When Slater decided to come to America, having in mind the severe penalties for smuggling machinery from England, he took no patterns or memoranda but relied entirely on his memory of the Arkwright machines which he had learned so thoroughly during his apprenticeship. He was financed by Moses Brown, a wealthy retired merchant of Providence, who was much interested in the manufacture of cotton goods. Slater also built two more mills in or near Providence in the course of the next eight years.

In 1793 Eli Whitney invented the cotton gin, which has done so much not only in assisting the cotton textile industry but in making the Southern States the world's chief source of supply for cotton.

From the flourishing conditions which preceded the War of 1812, the industry was plunged into its first severe test with foreign competitors after the war. Many of the small early factories failed to withstand the pressure of competition brought about by a sudden dumping of merchandise from English mills and there followed a demand for protective duties which were embodied in the tariff of 1816—somewhat to the displeasure of those engaged in shipping and the import trade which had flourished while the country depended so largely on others for so many staple articles.

Evidently the industry received an important impetus after the tariff of 1816, as is suggested by the following statement:

	Spindles
1805	4,500
1815	130,000
1825	800,000
1840	2,285,000

It is manifest that at the outset of the period, January 1, 1828, the industry was entering upon an era of important expansion. It was equipped with the machinery made possible by the fundamental inventions both English and American which had given the cotton mills their real beginnings. The industry had afforded the opportunity for one of the earliest and most important manifestations of the factory system. It had developed a distinctive form of organization.[1]

In 1827, a date almost coincident with the beginning of the hundred years with which we are dealing, water power, which had heretofore driven the mills, encountered its rival when Slater and his associates used steam successfully in a mill in Providence.

Four years later, or in 1831, John Sharp of Providence improved the spindle with a ring device destined to become a typically American feature of spinning and very largely to supplant the mule spindle in this country. By 1860, 50 per cent. of the spindles in this country were ring spindles, and by 1926 that percentage had risen to 94.

The progress of the cotton goods industry from 1830 to the present time may be inferred from the following statistics:

Year	*Number of Establishments*	*Active Spindles*	*Number of Employees*	*Cotton Consumed in Pounds*
1831	801	1,246,703	62,208	77,457,316
1840	1,240	2,285,000	72,119	126,000,000

[1] It is noteworthy that Francis C. Lowell, who had invented the power-loom in 1814 and made it possible for processes of spinning and weaving by machinery to be conducted in a single establishment, had also given the New England industry its scheme of organization, the principal of which was the Treasurer who was the executive head responsible for buying the raw material and selling the output. There was also an Agent at the mill performing the functions of a general manager. There was also a President but his powers were largely advisory or at any rate did not embrace any large degree of executive control.

Year	*Number of Establishments*	*Active Spindles*	*Number of Employees*	*Cotton Consumed in Pounds*
1850	1,094	3,998,000	92,286	288,558,000
1860	1,091	5,236,000	122,028	422,704,957
1870	956	7,132,000	135,369	398,308,257
1880	756	10,653,000	172,544	750,343,981
1890	905	14,188,103	218,876	1,117,945,776
1900	973	19,008,352	297,929	1,814,002,512
1909	1,208	27,395,800	371,182	2,332,262,636
1919	1,288	33,718,953	430,966	2,731,404,436
1925	1,366	35,032,000	445,184	3,066,389,683

It is remarkable that the rate of progress was continued on an upward curve so nearly uniform notwithstanding the disturbing effects of the Civil War from 1861 to 1865.

In the early '80's a highly significant movement began to take important shape. This was the development of the cotton textile industry in the cotton-growing states of the South. The progress of this development is strikingly shown by the following figures:

SOUTH

Year	*Number of Establishments*	*Active Spindles*	*Cotton Consumed in Pounds*
1831	7	9,844	1,152,000
1840	256	181,000	35,500,000
1850	166	265,000	39,000,000
1860	165	324,000	47,000,000
1870	151	328,000	34,500,000
1880	161	561,000	84,528,757
1890	252	1,554,000	250,837,646
1900	416	4,298,188	707,159,521
1909	526	10,222,472	1,162,969,470
1919	741	14,568,272	1,516,905,394
1925	810	17,292,000	2,055,108,104

The general tendency has been for the staple goods to preponderate in the output of the southern mills and the finer goods to preponderate in the northern mills.

During the interval between the Civil War and the World War great progress was made in the development of the productive processes of the industry.

It is probable that every process from handling the raw material to the packing of the finished product was affected by the improvements of this period. In spinning and in weaving, however, were changes which were truly amazing.

From 1870 until 1903 it is said that at least 373 patents were taken out for appliances or changes in spinning machines. The progress of the ring frame has been noted above. The spinning frame had been lengthened so that spinners can care for a larger number of spindles and the output per spinner, as a result, had been at least doubled.

One of the closest approaches to reproducing or superseding human skill in a machine may be seen in the automatic loom which was perfected and made commercially available by 1895. This remarkable machine is equipped with a bobbin-changing device, a felling hopper from which bobbins are automatically transferred to the loom shuttle and a peculiar shuttle which can be threaded automatically by the motion of the loom. It also has devices that act to stop the loom if the shuttle is not in place and a warp stop motion to prevent the making of poor cloth. It is so truly automatic in operation that it stops only when a thread breaks or the shuttle is out of position.

The World War created an enormous additional demand for cotton textiles for war purposes. This led to a considerable expansion in the capacity of American mills, and to a very considerable increase in running the mills (especially in the South) with day and night shifts. After the War the mills encountered the inevitable difficulties arising from the necessity for post-war readjustments.

The readjustment period is largely over and in supplying the peace-time demand the mills have closed the year 1927 with the largest production and disposition of cotton goods on record, except possibly for the war years of 1916-1917, although price conditions have frequently been far from satisfactory.

One of the striking aspects of recent years is the extent to

which the American cotton industry has been able to establish its independence of foreign production. This is suggested by the following contrast in the relative values of exports and imports of cotton cloth for 1899 and 1925:

Year	*Exports*	*Imports*
1899	$ 23,567,000	$32,265,000
1925	146,272,000	79,271,000

About 1875 a very few merchants became impressed with the fact that fine fabrics, then known as white goods, could be made in this country. At that time imported goods from Manchester, England, and the Continent of Europe supplied the market. Since then this country has made most remarkable progress in fine textile production and merchandising.

About that time a Rhode Island mill was making some numbers of combed plain goods known as Victoria lawns and in 1877 another mill developed a more extensive line, although it was not spinning finer than 70s warp. Shortly afterwards mills were equipped to handle Egyptian and Sea Island cottons and produce finer lines of white goods, including organdies, batistes, India linons, Persian lawns and a large variety of fancy fabrics.

Other New England mills soon followed in the production of combed yarn fine cottons and as the industry developed several large and well-equipped fine yarn mills were established in the South. Over sixty important establishments with some 7,000,000 spindles are now engaged in this branch of the business, the largest center being in New Bedford, Massachusetts, spinning yarns to 150s and producing an infinite variety of plain and fancy fabrics for women's, men's and children's apparel, also for household uses, such as curtains and draperies and other special cloths for various purposes.

To-day the cotton manufacturing industry is widely scattered, with some 1,366 factories in 31 states. Its capital investment is estimated at two billion dollars. The mill value of its products amounts to one and three-quarters billion per year. Its output in a single year now is approximately seven and three-quarters billion yards of goods. More persons are em-

ployed in its mills than by any other manufacturing industry, the number in 1925 being 445,184. At the present time these mills are capable of producing in one day more than a colony of craftsmen could spin and weave in a year.

The cotton mills are strikingly individualistic in their organization and policies. While there are some very large companies, and there have been some consolidations, yet there has been and remains an exceptionally large number of separate and independent organizations, and the tendencies to further consolidations appear to be decidedly moderate.

Another striking characteristic of the cotton textile industry is the extent to which the product of the mills is sold through commission houses or selling agents. Numerous important mills maintain their own selling departments within their own organizations, and others maintain subsidiary selling agency corporations. But to a very large extent, and apparently to a greater extent in the South than in the North, the mills, in order to effect the sale of their output, employ commission houses.

About the middle of the nineteenth century, the need for association within the industry led to the founding, in 1854, of the Hampden County (Mass.) Cotton Spinners Association. Its purpose was the encouraging of scientific investigation and experiment as to the methods of manufacturing cotton as well as the collecting and imparting of information relating to the industry. Eleven years later, it became known as the New England Cotton Manufacturers Association, and in 1906, its name was again changed to the National Association of Cotton Manufacturers. The association is, therefore, the oldest and one of the most active in the entire industry and while its membership was formerly composed of cotton manufacturing companies in New England, it now includes many from other sections of the country as well. With the much later development of the industry in the South it was not until 1903 that the American Cotton Manufacturers Association was formed to care for the interests of the southern mills, its objects and purposes being similar to those of the National Cotton Manufacturers Association.

In addition to these two regional associations, there are a number of state, local and technical organizations. Prominent among these are the Alabama Cotton Manufacturers Association, the Arkwright Club of Boston, the Cotton Manufacturers Association of Georgia, the Cotton Manufacturers Association of North Carolina, the Cotton Manufacturers Association of South Carolina, the Gaston County (North Carolina) Textile Manufacturers Association (representing mills making combed sales yarns), the Middle States Textile Manufacturers Association, the Fall River Cotton Manufacturers Association, the Fine Cotton Goods Exchange with headquarters at New Bedford, Massachusetts, the Rhode Island Textile Association and the Texas Textile Association. The activities of these associations deal largely with legislative and labor problems and in some instances, with traffic, welfare and publicity questions and the compilation and dissemination of statistics pertaining to particular branches of the industry. Membership in all of these associations is composed largely of mill executives. There are, however, associations devoted to the technical aspects of the industry, including the Southern Textile Association of Charlotte, S. C., in the South and the Southern New England Textile Club of Providence, Rhode Island, in the North. These organizations are composed of the mill superintendents and overseers and have for their objects the study of technical problems. Besides the many associations representing the manufacturing side of the industry, there are a number of others in affiliated branches, e.g., the Converters' Association, which was formed in 1912, and the National Association of Finishers of Cotton Fabrics, organized in 1914.

During the World War closer contacts than ever before were established among the mills and among their commission houses. After the War, doubtless influenced by the difficulties of the readjustment period, there developed a feeling that there ought to be more permanent opportunities provided for continuing these contacts.

The first step in this direction was the organization in 1918 of the Association of Cotton Textile Merchants of New York.

In the year 1925, this association took the important step of assembling statistics of production, stocks and orders, in respect to the mills represented by the commission houses.

Continued difficulties due to the enlarged capacity of the mills brought about by the War, and to the other difficulties of the post-war period, brought to the industry the conviction that some form of trade association, national in character, among the mills themselves was called for, and accordingly the Cotton-Textile Institute was formed in 1926. This Institute has a membership of 21,697,000 spindles, representing about two-thirds of the active spindles in the industry. It has entered upon a program of enlarging the statistics already being supplied by the Association of Cotton Textile Merchants, encouraging the most careful attention to all such statistics, encouraging more accurate ascertainment of the cost of goods manufactured, and promoting the extension of the uses of cotton goods, as well as seeking to induce the establishment of sound trade practices, the standardization and simplification of the fabrics made, etc., etc.

In the late fall of 1927 there developed very generally a conviction that the extremely large production of cotton goods was threatening to create stocks which would be highly demoralizing to prices, and as a result mills making some of the staple products have shown a greater tendency than before to give heed to the admonition of the statistics and to readjust their production so as to keep it more nearly in line with demand.

Dyeing and crude finishing was a household industry until cylinder printing was first used in this country in 1810. The machine as originally constructed was gradually improved by the addition of rollers which permitted patterns in a larger number of colors to be printed. In 1876 a double-faced machine was developed which printed eight colors simultaneously on both sides of the cloth.

From the best available records it appears that the introduction of chemical bleaching was one of the results of the War of 1812. It came about through the capture of a British sailing vessel by an American privateer, the "Yankee." When

the captain of the "Yankee" learned that two of the passengers on the captured vessel were acquainted with chemical bleaching he is said to have remarked that they would be desirable additions to the textile industry in this country, which at that time was dyeing its products in kitchens and bleaching the cloth out of doors on the grass. Accordingly he landed these passengers, Daniel and Duncan Wright, at Bristol, R. I., and secured employment for them in a factory in Dighton, Mass., in which he was interested. To these two men and members of their families the foundations of the bleaching branch of the industry are attributed. From this beginning domestic finishing has kept pace with domestic requirements until to-day one of our establishments is equipped with fifty printing machines, probably the greatest single unit in the world. In 1925 there were 697 dyeing and finishing textile establishments in this country, employing 70,749 wage-earners and turning out products valued at $432,537,000.

The distribution channels of cotton textiles have undergone radical changes in the last hundred years. At the beginning of that time, distribution was effected largely through the great auction houses in New York, whose chief business was in dry goods, and through a number of very large wholesale dry goods merchants located in that city and dealing mostly in British goods. Boston, Philadelphia and Baltimore were successful rivals of New York in the wholesale dry goods business. By degrees the great wholesale houses in the East have given place to smaller wholesale houses scattered throughout the country, and apparently with an ever increasing tendency to the establishment of smaller units nearer to their customers. There has also developed an increasing tendency on the part of very large retail establishments to buy direct either from the mills or from the converters. Syndicates have been developed in order to buy direct for smaller retail establishments. Mail order houses have been developed to buy from the mills and sell directly to the ultimate consumers.

Some fifty years ago there were in New York probably less than ten converters, i.e., individuals or firms having no manufacturing or finishing plants but buying gray cloth from mills

which they then sent to finishers to be bleached, dyed or printed before offering for sale. Some converting was also done on a few lines by importing and wholesale houses. To-day, however, there are many hundreds of independent converters and a few of the larger mills have finishing plants and convert their own and purchased gray goods. The variety of goods handled in this way has increased enormously during the period named and has resulted in the establishment of the many important printing and finishing plants to which I have referred.

The complexity of these rapidly changing channels of distribution has created new problems and one of the efforts of the Cotton-Textile Institute is to bring into closer contact the principal agencies of distribution, including wholesalers and retailers, with a view to defining and considering the problems thus arising.

IX

PULP AND PAPER

By Hugh P. Baker

Director, American Paper and Pulp Association

WITH every man, woman and child in the United States using more than 200 pounds of paper this year, and with amazing developments in new uses of paper under way promising further increase in per capita consumption, it is easy to appreciate the paper industry as a fundamental American industry and every individual in the country, young and old, as a customer of the industry. Whether the large use of paper and paper products in this country indicates an unusually high level of literacy or prosperity may be a question. It is significant, however, that the per capita consumption of paper in the United States is more than double that in any other nation of the world.

We use paper as one of the most common and ordinary things entering into the daily routine of life. We accept it as a continuous necessity with little or no thought of the labor, the money and the brains which have been used to produce it. From the kitchen to the office and to the great industrial plant, paper is being used in ever increasing quantities. My neighbor, a suburban commuter, after his morning toilet and breakfast, lays down his paper money to buy a paper railroad ticket, gets onto the train and opens his newspaper, is reminded of something that he must do during the day and takes out his notebook and with a paper pencil jots down a note. If he enters the smoker he may take out his paper-wrapped cigarettes with at least three different kinds of paper in the package and use a paper match to light one. On his desk he finds a stack of letters on paper of great variety and distinction and as he dictates

the notes are made in a paper notebook and then transmitted onto the machine on more paper, and still more paper, and so on through the day. If he gives any thought to paper it may be that the texture, the color, or the grade, do not suit him or he is attracted by a beautiful bit of advertising on an especially fine piece of paper. He seldom appreciates the fact that an industry with a capital of over a billion and a half dollars is back of the paper which he is using from morning to night and that this industry is calling upon the forests from Maine to Oregon and upon the cotton fields of the South, for raw materials for the manufacture of paper and that the industry, after the raw materials are brought together, fabricates them with great skill into paper which is finally brought to his hand for daily use.

But the paper industry has not yet reached the limit of its possible development and achievement. The needs of the individual and of industry are causing the research man in the pulp and paper mill, in the laboratories of the government and of the technical schools, to seek for new grades and new forms of paper. Until quite recently pulp made from wood was just woodpulp, to be used for the manufacture of the coarser and more common grades of paper, such as newsprint, wrapping paper and paperboard. Economic pressure and growing demands have caused research to be applied to woodpulp and it has been found that almost pure cellulose can be produced. From this highly refined woodpulp rayon and other highly specialized products are being manufactured in ever increasing quantities. The manufacture of very satisfactory artificial woolen cloth from this super-refined pulp is just in the offing.

Any description of the pulp and paper industry in the climax of its present day development would be incomplete without referring to the specialized products using woodpulp and paper as raw materials. Absorbent material known as "Cellucotton" made from woodpulp is being used widely in hospitals in the place of absorbent cotton and in many ways is superior to cotton for medical use. This paper material, in the form of wadding, has found a place in the dentist's office, the barber shop, the confectionery store, and so on down the line. The paper doilie and the napkin, with the monogram stamped in its

corner, the paper towel, and innumerable other products of woodpulp and paper are coming into effective competition with wood and metal and textiles. And, of course, one must indicate the use to which pulp and paper is being put in building construction and as materials entering into processes of manufacture in the electrical industries, automobile industry, for instruments of precision and in many other industries.

Indeed the present is a paper age and to-morrow will see greater use of pulp and paper and their products and greater development in the technique of producing these invaluable commodities.

For nearly 100 years after the permanent settlement of this country, so far as records indicate, no paper of any kind was produced in the Colonies. Paper was expensive and a luxury to be used by the well-to-do only, for limited correspondence, and in the form of books and as decorative wall coverings. All of the paper used in this country until nearly 1700 came from the older countries, largely from England. With the developing desire for greater independence from the manufactured goods produced in the old country simple beginnings in the manufacture of pulp and paper were made by the Colonies. About 1690 the first paper mill was licensed to operate at Germantown, Pennsylvania. A part of the original building of this first mill still stands in Fairmont Park in Philadelphia.

The most primitive methods of producing hand-made paper were used in the Germantown mill and pounds were turned out daily where tons are produced in the modern mill of to-day. Soon after 1700 one or two small mills were started in Massachusetts and New York but not until after the Revolution was any real effort made to produce paper to supply even our limited needs.

During the Revolution and after some exceedingly interesting appeals were made to the people, both by the Continental Congress and by the officers of the Army, to save their rags that there might be paper made in sufficient quantities to meet the needs of the Army and of the new Government.

When the first Provincial Congress in Massachusetts met in Salem in 1774 the Committee on Manufactures reported the

necessity of encouraging the making of paper, and the Convention voted:

"That as several paper mills are now usefully employed, we do likewise recommend a preferable use of our own manufactures in this way, and a careful saving and collecting of rags, and also that the manufacturers will give a generous price for such rags."

A year later the proprietors of the mill at Milton, Mass., memorialized the Provincial Congress that they were not able to get sufficient quantities of rags even though they had raised the price that they were willing to pay. Accordingly, the second Congress, at its session in 1776, at Cambridge, Mass., took action as follows:

"Therefore, Resolved, That it be recommended, and it is by this Congress accordingly recommended, to every family in this province, to preserve all their linen, and cotton and linen rags, in order that a manufacture so useful and advantageous to this country may be suitably encouraged, and it is also recommended to our several towns to take such further measures for the encouragement of the manufacture aforesaid, as they shall think proper."

Later in 1776, the Massachusetts House of Representatives, the Council concurring, took this action on the rag situation:

"Whereas, this Colony cannot be supplied with a sufficient quantity of paper for its own consumption, without the particular care of its inhabitants in saving rags for the paper mills;

"Therefore, Resolved, That the Committees of Correspondence, Inspection, and Safety, in the several towns in this Colony, be and they hereby are required immediately, to appoint some suitable person, in their respective towns, to receive the rags for the paper mills and the inhabitants of this Colony are hereby desired to be very careful in saving even the smallest quantities of rags proper for making paper, which will be a further evidence of their disposition to promote the public good."

Until wood came into the industry as an important raw material for the manufacture of pulp and paper, between 1865 and 1870, there was little idea of the manufacture of pulp as separate from the activities of the paper mill. While it is a com-

mon thing to-day for a pulp mill to be built as a separate plant for the production of pulp only, there was no thought in the minds of those who developed the industry during its first hundred years in this country of the production of pulp from rags as in any way separate from the manufacture of paper. Therefore, plants were not constructed especially for the manufacture of pulp from rags and in fact there has not yet been developed a separate rag pulp mill. This distinction between the production of ragpulp and woodpulp has had marked influence through the years in the location of the paper mill and in its construction and operation.

As the paper mills built and operated in this country for the hundred years prior to 1827 were very simple manufacturing plants, where hand labor was used rather than machine labor, and where the only outside condition necessary to the plant was a permanent supply of water for power and process, it is probable that the primary factor affecting the location of the earlier mill was water. Nearness to a population supplying rags and a market was a condition rather secondary to a satisfactory supply of water. When one knows of the requirements of the modern pulp and paper mill it is surprising indeed to see where the earlier mills were located and one wonders that they could have been operated through the years on a profitable basis, as doubtless they were. A stream of good, clear water, large enough to run a small water wheel, was apparently about the only necessary requisite in deciding as to location. The source of raw materials and the market were local. Rags were brought to the mills by wagons, they were turned into paper largely by hand, the paper was loaded onto wagons and taken to the print shop and the stationer, who was then the sole distributor of the product of the mill outside of the print shop.

Gradually as the industry developed and larger mills were built there was need for more water for process and power, and mills were located on the Connecticut and other rivers in New England, on the Hudson River in Eastern New York, the Black River in Western New York, and gradually, as western developments began, along the Ohio and its tributaries, the Fox and the Wisconsin, and so on westward.

Not until wood began to be used as a raw material for the paper industry, in the late '60's of the past century, did the nearness to a supply of raw materials become an important factor in the location of mills. To-day, while an abundant supply of water is an essential in the location of the mill, water for power is no longer an important consideration, in fact the development of the transmission of electric power, which is now generally used in the mills, has made the factor of water power an unimportant one in deciding the location of a mill.

The necessity for supplying the limited needs of the Colonies and the Continental Army may be said to be the first real urge which brought about the building and operation of paper mills. This first response to demand for the building and operation of mills was very different indeed from the urge which in more recent times has caused the building of pulp and paper mills. The presence of available supplies of wood in virgin forests, plus available water power, has attracted capital and mills have been built in recent years as an outlet for capital rather than as the result of market demand.

In the first years of the industry paper mills were usually built by individuals and the mill was family owned and operated. With primitive machinery and the production of a few hundred pounds of paper a day only it was the common thing for the owner to be purchasing agent, manufacturer and merchant. Gradually men came together and formed partnerships but still the mills were family owned. It is only within the past few years that corporation ownership has come gradually to take the place of family ownership. Fortunately a few of the fine old mills, particularly in New England, continue in family ownership and paper is still being produced as a matter of tradition. Changing economic conditions and increasing competition are such, however, that each year sees a gradual change toward corporate ownership and control in the paper industry.

By 1827 the paper industry was well under way as an American industry, with mills scattered from Pennsylvania northeastward to Eastern New York and throughout Massachusetts. Records do not indicate the number of mills which were in operation by 1827 but from such records of industrial develop-

ment as are given in local and state histories, it is probable that there were not less than 400 mills turning out various grades of paper from 100 and more pounds a day up to possibly a ton. The moving wire for the laying of the fibers into a sheet of paper had come into use in some of the newer and larger mills, but the hand frame or screen was still used in many of the mills. Buildings were small, usually of brick or stone, and equipment was simple and very limited in extent.

The Germantown mill of 1690 was started with the most primitive equipment and doubtless was manned by three or four skilled workers brought over from the old country. The first mills built in New York, Connecticut, Massachusetts, and other parts of New England, were equipped much as was the Germantown mill and operations were carried on by skilled laborers from England, France, Holland and Germany. While the mills from the earliest day to the present time have continued to use skilled laborers from abroad, yet more and more during the first hundred years workers were trained by serving as apprentices and after the expiration of the period of apprenticeship either stayed on in the mill in which they began or went on into new mills as they were built. Many if not most of the men who became leaders in the industry as the years passed started in the earlier mills as boys, gradually working up until they became foremen, superintendents, and finally executives and owners of the mills.

The character of operations in the earlier mills was such that skill was acquired through serving of time and the learning of rule of thumb methods. In many instances processes were considered to be secret and visitors from other mills or from the outside were not admitted to the mill. It is probable that there are few other great industries of the country which have developed so rapidly and so fully as the pulp and paper industry, where rule-of-thumb methods have persisted for so long a period of time. While the period being discussed is 100 years prior to 1827, yet it is safe to say that 100 years later, that is 1927, the industry is still employing rule-of-thumb methods in certain phases of operation and the industry is unfortunately still far from any general acceptance of technical control.

The primary raw materials used in the paper industry up to 1827 were entirely cotton and linen rags. These were purchased from householders directly at the mill or rag men circulated through the country, buying them from householders or exchanging them for other commodities. Sometimes the rag men were in the employ of the mills but more usually were independent hucksters who not only picked up rags but other forms of waste material. In the beginning, as the rags were received at the mill, they were sorted, usually by women, who would remove buttons and metal parts and who would eliminate pieces of woolen and silk material so that the rags as they went to the washers were entirely cotton or linen and free from metal. The buttons, pieces of whalebone and metal removed were sorted and re-sold and re-used. Not until well into the nineteenth century were machines installed for the thorough dusting of rags before they went across the sorting tables. As in other industries, these machines for the cleaning of the raw material before it was hand sorted were introduced partly as the result of pressure on the part of labor itself, that the raw materials might be more sanitary before being handled, and partly as the result of the ingenuity of the manufacturers themselves, who were constantly seeking methods of producing cleaner and better pulp for the manufacture of paper.

After the cleaning of the rags, following the sorting and washing, they were put into retorts or digesters where they were boiled in the presence of caustic materials to loosen the dirt and remove extraneous material. From the digesters the pulp was passed to the beating machines which were so constructed as to cause the movement of the pulp around the vat; through knives working on a bed plate in the bottom of the beater the pulp was washed and still further reduced to a fine fibrous material. In all of these processes a great deal of water was used and, of course, the water had to be clean and free from iron and other mineral substances. In many cases this necessitated the treating of the water for the precipitation of these mineral substances. In other words, good, clean pulp could not be made without good, clean process water.

From the beaters the pulp was run into stock or stuff chests

and from these chests was taken out in the hand molds or was run onto the paper machines where the fiber was laid into a sheet of paper through continuous use of process water. For certain grades of paper the pulp had to be bleached white and coloring matter was added usually in the beater, so that the pulp as it reached the stock or stuff chest had been bleached to a clear white or had been colored as desired.

As the cotton and linen fibers, in suspension in water, were run over the paper machines, the wire moved slowly enough so that a great deal of water was drained away before the sheet was caught by the felt and led onto the rolls. As time passed various appliances for the drying of the sheet were introduced so that the sheet of paper might be practically dry as it reached the roll. These appliances will be described later.

As the paper was carried from the machines onto rolls it was cut into sheets which could be handled easily by hand and hung in lofts to dry. At first these lofts were heated in a very crude way, often by ordinary stoves, and only gradually the lofts came to be heated by steam or hot air. After the paper had hung in the loft, often for weeks, and had become practically air dry, it was taken from the loft finished and packaged, ready to be sent to the printer or cut into sizes for correspondence and other use.

While the manufacture of paper, which has been rather simply described, involves certain mechanical processes, its production was considered to be the result of the most skilled craftsmanship and a great deal of art entered in from the beginning until the end.

Until 1827 and in fact for many years afterward, the development of the paper industry, both from the standpoint of the quantity of paper produced and the machinery and processes used, was exceedingly slow. As in the days of the Revolutionary War, paper was expensive and almost a luxury and therefore newspapers and books were not abundant and the per capita consumption of paper was very limited. Even in the cities the editions of the newspapers were small and the daily paper was still a matter of future development. In the smaller communities the arrival of the weekly newspaper was

an event and people gathered in the stores or at the clubs to hear the papers read. In the homes of even the well-to-do books were a rarity. The family Bible, and perhaps a few other religious books, were about all that one would find.

The improvements that have taken place in machinery and process have come largely through economic and cultural pressure but also through the application of the knowledge and the ingenuity of the inventor, the engineer and the chemist. Developments that would make paper reasonably cheap and available for use by large numbers of people came only with the change in primary raw material.

As paper was made almost entirely by hand, from the time of the Germantown mill of 1690 until about 1827, it might be called the period of primitive development. After going through a modern paper mill one would hardly appreciate that the mills as they were operated up to 1827 were paper mills.

In the primitive period of hand-made paper the pulp made from the rags was kept in suspension in stock or stuff chests by agitation and a small hand frame, across which a fine mesh wire was stretched, was dipped into the vat or chest and by dexterous motion the frame was lifted out of the chest, the water draining away and leaving the fibers in form of a sheet of paper on the wire. Shortly after 1800 a craftsman in France, who would now be called an inventor, found that he could form the sheet of paper a little more rapidly by running the pulp in suspension in water onto a wire which was kept moving over a narrow frame. After some improvement this machine was taken into England by a man by the name of Fourdrinier and it, therefore, received his name, though he was not the inventor. The Fourdrinier wire or machine was introduced in this country about 1825 and was put into practical use in some of the mills soon afterward. It may be said, therefore, that the hundred years following 1827 is the period of machine development in the pulp and paper industry. The introduction of the Fourdrinier machine, as crude as it was, came very rapidly in American mills after 1827, and by 1850 most of the paper produced was machine made.

From the first Fourdrinier machine, with a wire running

over a frame not more than three or four feet wide, and at very low speed, gradual development has taken place until to-day in some of the great mills manufacturing newsprint paper there are Fourdrinier machines with wires more than twenty feet wide, running at a speed of nearly a thousand feet a minute. There has been very little improvement in the Fourdrinier machine except in the way of increasing size and speed of the wire. It is rather difficult to forecast what may be the future development of the paper machine. There are numerous technicians in the industry who are saying that the modern, high speed machine has reached about the limit of its development.

With the coming of the rapid moving wire on the paper machine, and particularly with the introduction of wood as the principal raw material for pulp, there has followed a demand and a need for improvement in process for the reduction of rags and wood to pulp, and in the handling of the pulp in such a way as to produce the most satisfactory results on the modern machines.

But little improvement has taken place in the Holland machine or beater. It has been made larger and its form has been changed somewhat but it is still much the same as the original Holland machine. As the chief purpose of the beater is the refinement of the pulp and its proper mixture with water, coloring matter, etc., other machines have been developed to do the same type of work. The so-called Jordan machine, developed during the past forty years, has come into use to do practically the same work as the beater in the refining of pulp. During the past half dozen years the rod mill, developed for the mining industry, has come into use and with further improvement it may in time take the place of the beater. The rod mill is a steel cylinder in which there are a number of steel rods which, as the cylinder revolves, tumble over each other and as pulp is introduced the rods refine it by a sheering or tearing action. As the ordinary beater consumes a great deal of power, and as the rod mill consumes very much less, it may be, with further development, that the rod mill will gradually take the place of the beater, especially as it seems to cut and destroy the fibers less than the beater.

With the introduction of the paper machine the most serious problems with which the paper manufacturer was confronted were the getting rid of the water in which the fibers were carried onto the wires, quickly and with as little loss of fiber as possible, and the drying of the paper by processes that would do away with the hand labor involved in loft drying. The first step in getting rid of the water was the introduction of the press roll. This was a roll or cylinder, in fact two cylinders, through which the sheet was run after it reached the felt and which by a squeezing action took out a great deal of the water from the sheet of paper. Within the past decade there has come also the suction roll, which aids further in the removal of water by sucking a part of it from the sheet before it has passed through the press roll.

The first development which came in the drying of the paper before it was finally taken from the machine was the introduction of drums heated with steam over which the paper was run. Gradually a number of drying cylinders were added to the machines until to-day, as the paper comes from the drying drums it is ready to be given further treatment or run on cores and shipped directly to the great newspaper and printing houses and wherever paper is used in rolls.

Great progress has been made in improving the surface of the paper, particularly in book paper and other higher grades of paper. The surface of the sheet of these higher grade papers as it comes from the dryers is not satisfactory for ordinary printing purposes; therefore it is given special after treatment such as being ironed smooth or calendered. In fact the calenders are simply a series of cylinders through which the paper is run and which does for the paper what the ordinary hand mangle does for linen or cotton goods as they go through the laundry. The ironed or calendered surface could not be given to the paper, of course, if the paper were not properly sized, though sizing is used primarily to give desired degree of water resistance. This is done by running the paper through a bath of different combinations of glue or casein or starch. Marked development has been made in the application of sizing to paper and there are in use to-day certain sizing

materials which add qualities to the paper which make for greater imperviousness to water and greater strength.

With certain of the higher grades of rag content papers, where use to which the paper is to be put justifies the expense, the surface of the paper is improved or patterned by plating. Paper is cut in sheets of certain standard sizes and placed between metal plates. A certain number of sheets of paper and plates, bundled together, are then put into hydraulic presses and the resultant pressure marks the surface of the paper either in certain patterns or brings it out as a perfectly smooth sheet.

The greatest progress in processes for the manufacture of pulp and paper in the immediate past and for the future will be in the reduction and refinement of the primary raw materials used in the industry. Surprising progress has been made in the improvement of various processes for the reduction of wood to pulp.

A recent almost revolutionary development has come through the application of the explosive principle in the reduction of wood to pulp. This new process is so simple that one wonders why it was not discovered and used years ago. This process is now being used on a commercial basis at Laurel, Mississippi, where waste from a saw mill is being chipped and run into a steel cylinder, carrying a charge of about 500 pounds. Live steam is introduced at about 350 pounds pressure and then within less than a minute is raised to approximately a thousand pounds of pressure. The cylinder is then opened and the wood torn to a pulp is shot out in form to be used with a certain amount of after treatment for the manufacture of a very satisfactory insulating board. This insulating board, because of the fact that the fibers of the wood are retained almost intact and that they lie across each other, giving a plywood effect, is probably the nearest approach to synthetic lumber that has yet been achieved. This new insulating board, known as Masonite, is finding a ready market for construction and for other purposes.

It is within the range of possibility that this exploded wood can be used as the first step in the various chemical processes now generally used for the reduction of wood to pulp. If this

is possible it would mean a very great saving in time and, therefore, in the cost of producing woodpulp for the paper mill.

So many improvements have been made from time to time in the various processes for the reduction of wood to pulp that it is entirely conceivable that to-morrow we may be confronted with a new process, perhaps a combination of present chemical processes or a combination of mechanical and chemical processes, that will require the scrapping of much if not all of the machinery now being used in the pulp mills of the country.

The development of electrical power for industrial use has affected the pulp and paper industry as profoundly as it has many other great industries of the country. There are few pulp and paper mills in this country to-day where electrical power is not the chief power and the more modern mills are being electrically controlled to a complete degree. The electrical drying of paper has already been perfected and it is only a question of time when the electrical dryer will take the place of the steam or the hot air dryer.

Interesting developments are taking place in the treatment of paper after it leaves the mill, or in the mill, with certain mineral substances which may increase strength, imperviousness to moisture or durability. Fiber or paper board, which is used so widely for cartons for shipments of all sorts of commodities, is being impregnated with pure sulphur, with results in the way of increased hardness, imperviousness to water, and a certain increase in strength that is surprising. Research is being carried on in the mineralizing of other forms of paper which may result in a much wider use of paper in competition with other commodities.

From the raw material standpoint the paper industry in the United States is unique in that it has almost completely changed its primary raw material within a human generation, that is, since the close of the Civil War. Up until the time of the Civil War, and for some little time thereafter, cotton and linen rags were the principal primary raw materials for the manufacture of paper. The industrial expansion which began in the late '60's brought pressure upon the paper industry for more and

cheaper paper. Certain of the leading manufacturers in Eastern mills, knowing of developments in the industry abroad, went to Europe for a study of the pulp and paper industry as it was developing there. One of these men, Mr. Albrecht Pagenstecher, was the first to secure a license from abroad for the manufacture of pulp from the softwoods, such as spruce and balsam fir, by the mechanical method. After some experimentation with American woods, Mr. Pagenstecher produced the first groundwood or mechanical pulp to be made in this country at his mill at Interlocken, Massachusetts, in 1867.

The first woodpulp produced, whether groundwood or chemical pulp, was crude material, much too dark for use in producing the ordinary forms of white paper. However, the possibility of producing pulp from wood, coupled with what appeared then to be almost unlimited forests of softwoods, soon convinced the paper manufacturers that paper could be produced much more cheaply from woodpulp than from cotton and linen rags. Investigation and research were applied to the problem of better pulp from wood and soon practical means were determined for the refining and the bleaching of woodpulp to the point where it could be used in the manufacture of newsprint and the cheaper grades of book paper.

It may well be said that with the introduction of woodpulp as a cheap and easily produced raw material for the manufacture of print paper there followed the development of the modern rotary printing press, which has made possible the newspaper and the cheap book as we know them to-day.

While more than 60 per cent. of the ten million odd tons of paper manufactured annually in this country to-day is made wholly or in part from woodpulp, and while cotton and linen rags represent but 4 per cent. of the primary raw materials going into the manufacture of paper, it is certain that rags will continue to be used for the manufacture of the higher grades of paper where such characteristics as durability and permanency are required.

Through the years since wood began to be used in quantities, that is from the early '70's, the virgin forests of the Eastern states particularly have been cut away until each five-year

period, and now almost each year, the mills are going further afield for their pulpwood. In certain instances to-day pulpwood is being transported from the forest to the mills by rail and by water for distances of from six to eight hundred miles. While wood is a fundamental necessity in the manufacture of pulp and paper, yet the amount of pulpwood used by the paper industry is not a serious annual drain upon the forest. In fact the total amount of wood used in the pulp and paper industry in 1926 represented only a little more than 4 per cent. of the total wood cut during that year in the United States.

The wide ramification of use of paper in the United States indicates the present as the age of paper. This is so largely because the industry has changed from the use of primary raw materials, limited and uncertain in supply, to a raw material based upon a renewable natural resource—the forest. The paper industry is indeed founded upon the wood pile. Naturally, during the sixty odd years of use of wood for the manufacture of paper in this country, much has been learned as to the use of wood and there is beyond doubt still much more to learn. The yield in quantity and in quality of fiber has been increased steadily through the years.

The very fact that wood has come into use in the industry within the past generation indicates in a way the youthfulness of the industry from a raw material standpoint. Rapid progress is being made in the refinement of woodpulp and it seems to be only a question of time when cellulose produced from wood will be a very effective competitor of the cellulose produced from the cotton plant and with wool.

Partly because the softwoods, so-called, such as spruce and fir, were the tree species from which woodpulp was first made in Europe, and partly because these species lend themselves admirably to reduction to pulp, the principal species still being used for the manufacture of pulp and paper are such softwoods as spruce, balsam fir, hemlock, and, in more recent times, pine. Certain West Coast softwoods not found in the Eastern United States are rapidly coming into use. Not only because the industry began the production of pulp from the softwoods and because these species lend themselves to easy

reduction to pulp, but rather that a better quality of fiber is produced from the softwoods, and the pulp lends itself well to such after treatments as bleaching, coloring, etc., has caused the industry to continue to depend largely upon softwoods.

With the introduction in the early '80's from Scandinavia of the so-called sulphate process for the reduction of wood to pulp, it was found that this process is particularly valuable in the use of such resinous woods as the southern pines. The past few decades have seen rapid development of the sulphate pulp industry in the South, where the rapid growing pines, such as the Loblolly or Old Field Pine, the Short Leaf Pine and the Slash Pine, are being used in increasing quantities. So far the only papers that can be produced on a satisfactory commercial basis from sulphate pulp are so-called kraft papers and various forms of board. Recent investigations in the laboratory have shown that the resinous matter in the wood can be gotten rid of so that the sulphate pulp produced from these resinous woods can be bleached white. Just as soon as these laboratory processes can be applied on a commercial scale, so that the cheaper printing papers can be produced from Southern sulphate pulp, there promises to be even more rapid development of the industry in the South than has already taken place.

So far in the development of the industry on the West Coast it has been possible to use the Red or Douglas fir and the western pines satisfactorily for pulp only by reduction under the sulphate process. Kraft paper and so-called kraft board are already being made from sulphate pulp produced in western mills and there is as large promise for the future development of this particular phase of the industry in the West as in the South.

With the introduction of the soda process, so-called, for the reduction of wood to pulp in about 1852, there came into use the production of soda pulp from certain of the hardwoods. This process is particularly adapted for the reduction to pulp of such hardwoods as the cottonwoods, yellow poplar of the South, bass-wood, maple, etc. This pulpwood has rather a short, weak fiber, but it has certain special qualities which

make it of value in the manufacture of book papers. With the gradual development of this process, and with the softwoods becoming somewhat more difficult to secure from year to year, it has been found that almost any of the hardwoods except those containing tannic acid can be used for the manufacture of soda pulp. To-day an increasing cordage of the hardwoods is going into the manufacture of pulp under the soda process. This is indeed a significant development as there is a great deal of second-growth hardwood timber standing in the Eastern and Southern Atlantic States, and it may be that these stands of hardwood, now generally available to the pulp mills, will play a considerable part in tiding the industry over the period of lean years from the time of the exhaustion of the larger stands of softwoods to the time when new forests will be produced, either as the result of natural or artificial regeneration.

Forestry, which may be defined as the management of forsets and forest lands in such a way as to produce the maximum amount of the right kind of wood on a continuous basis, is fundamental to the permanency of the raw material supply for the paper industry.

As applied to the proper handling of forests and forest lands, forestry has no particular mystery in it but rather it is simple in application. Trees are a crop from the soil and the application of forestry means the protection of the trees and the forest in such a way that the land producing these trees may produce more and better trees on a basis that will insure continuity of product and a product of the greatest possible value for the use to which it is to be put.

The question is often asked to-day as to why forestry is not practiced more generally in this country. The answer in a way is a simple one, and that is that through the years wood has been too cheap to justify the expense of protection and proper management of the forest. As long as there were extensive virgin forests, where wood could be gotten practically for the cost of cutting, and where the cost of the wood produced was below the cost of producing new crops, there was no particular incentive to make forest lands continuously productive. With

the cost of wood, generally speaking, rising steadily, the time has now come, at least in the eastern half of the continent, when the cost of wood has passed the cost of production. Therefore, when such deterrent factors as forest fires and wrong methods of taxing the forest can be overcome, wood will be grown as other crops from the soil are produced on a practical, business basis.

Great progress has been made in protecting forest lands from fire. Each year, as economic conditions justify the expenditure of funds necessary for the protection of forests from fire, we come a little nearer to the ultimate goal in protection; that is, the making of the forest an insurable risk. Practical organization and management in protecting forests from fire will in time largely eliminate fire as a deterrent factor in the production of new forests. After all, we must approach the problem of protecting the forest from fire just as we do the problem of fire in our villages and cities. As we lay out our cities and build buildings, so as to make the city as safe from fire as possible, so we must organize or lay out the forest and develop it in such a way that we will not have an unusual fire risk or hazard. In the forest, too, the same procedure in fire fighting must be followed as in the city, after the proper protective means have been carried out. There must be means by which a fire when it occurs can be located immediately and this is accomplished in the forest through the use of fire towers and telephone systems. It must be possible then to get men trained to fight fire, to the point where the fire breaks out as quickly as possible. The goal of the forest as an insurable risk has already been reached in certain sections and forest fire insurance has already been written.

Another deterrent factor which has increased the complexity of the problem of fortifying the wood-using industries with a permanent supply of raw material is the wrong form of taxing the forest which has been applied through the years. The taxing of growing forests on an annual basis is wrong and is manifestly unfair to the timberland owner. The farmer's growing crops are not taxed. Until this wrong method of taxing timberlands on an annual basis can be changed we can

expect that the virgin forests will continue to be cut as they have been in the past and that the land owner will not assume the burden of producing a new crop, to be taxed annually. Some progress has been made in overcoming this deterrent factor of wrong taxation of the forest. A number of states have recently passed laws which make it possible for the timberland owner to declare his lands as forest lands and thereby have them assessed at a low land or soil value with a yield tax to be paid when the crop is cut.

While the forests of the country are being steadily overcut, and while we will probably continue to cut our virgin forests in the old way until they are exhausted, yet such progress has been made in the protection of forests from fire and in the direction of the right basis of forest taxation, that there is real promise for the production of wood by both the public and the private owner on a commercial basis in this country. These improved conditions have resulted in such interesting accomplishments as—more timber standing and growing in New England to-day than there was fifty years ago. While it is quite probable that conditions may have to become worse before they become better, yet the forest situation is not at all an impossible one and there is every reason to believe that from now on every decade will see more rather than less forests growing in this country. Therefore, the paper industry and other wood-using industries are being fortified with a permanent supply of raw material.

Any story of the developing use of primary raw materials for the manufacture of pulp and paper would be incomplete without reference to what are known in the industry as substitutes for wood, such as straw, corn stalks, various grasses, etc. While paper can be made from almost any vegetable fiber, and while considerable quantities are being made from straw to-day, it is not at all probable that wood will ever be replaced by these so-called substitutes as the principal raw material for the industry.

Factors which seem to stand in the way of the practical use of substitutes are expense of collection in sufficient quantities to keep a modern pulp mill operating twenty-four hours a day

for 300 days a year; low yield of fiber; and poor character of the fiber after the pulp has been produced. It is true that where there have been repeated failures over the years in attempts to use certain grasses and other substitutes for the manufacture of paper, that changing economic conditions may bring these substitutes into practical use. An interesting example of this is the way in which, after years of experimentation and failure accompanied by expenditure of large sums of money, the discovery that paperboard could be used as wall board for house construction led finally to the successful use of bagasse, which is spent sugar cane, for the production of a wall board which is now a common product on the market.

There is a very interesting and somewhat tragic story, from a financial standpoint, in the effort which has been made in this country to manufacture pulp and paper from corn stalks. The first patent on a process for the manufacture of pulp from corn stalks was granted by the Federal Government in 1802. Approximately every twenty years since that time there has been an outbreak of interest in the possibility of putting the production of pulp and paper from corn stalks onto a commercial basis. In other words, in about every human generation, since 1800, some investigator in a laboratory has decided that he has stumbled upon something entirely new and that his process for the production of pulp and paper from corn stalks will make possible the utilization at a profit of what seems to be such tremendous waste on the farms of the country. Therefore, periodically, companies, for the manufacture of pulp from corn stalks, have been formed, financed and operated for a time and then have failed. During the past year there has been another outbreak of interest in this very attractive idea of utilizing the hundreds of thousands of millions of tons of corn stalks accumulated annually on American farms for the production of pulp and paper and more companies have been formed. There is as yet no real assurance that this particular waste material can be used on a basis that will allow its product to compete successfully with pulp and paper made from wood and cotton fibers.

The use of these substitutes, as indicated in the reference to

the use of bagasse for the manufacture of wall or insulating board, is after all an economic question. A real scarcity of wood in any given region might well bring about conditions that would justify the use of certain substitutes. However, with real promise of aggressive development of forestry in this country, with all that it means in putting the idle forest lands of the country to work in the production of wood, there seems little likelihood that any of the plants producing fiber for the paper industry, other than the woody plants and cotton and flax, will ever be used in any large way in this country.

In enumerating the various raw materials which are used for the production of pulp or paper reference should be made to the progress which has been made in the remanufacture of paper. Every one is familiar with the way in which waste paper is gathered from office buildings and from homes, to be used as paper stock. While a certain amount of waste paper has always been used, with the so-called broke in the mill going back into the beaters, it is only since the production of paper or fiberboard on a large scale was begun that paper stock has been used in large quantities. In 1926 more than 30 per cent. of the primary raw materials used in the industry was waste paper. A careful estimate indicates that approximately 4,000,000 tons of paper stock, valued at more than $60,000,000, was used last year, in the manufacture of paper or fiberboard of all grades.

As with the use of all of the other raw materials, the use of paper stock is again an economic matter and it is safe, therefore, to assume that as the cost of various grades of pulp increases the amount of paper stock used will also increase. In fact the possibilities in the remanufacture of paper are not at all exhausted.

An announcement by one of the leading New York dailies a short time ago that it has used a thousand tons of newsprint paper in the printing of a single Sunday edition is an interesting emphasis of the part which paper is playing in the daily lives of the American people. On every hand and in every domestic, business and industrial activity, paper is being used in ever increasing quantities. Last year the per capita consumption of

newsprint paper was 58 pounds, of book paper 23 pounds, of wrapping paper 23 pounds, of paperboard more than 60 pounds, and altogether there was a total per capita consumption of over 200 pounds of paper, which is more than twice the per capita consumption of paper in any other nation.

One very interesting development in the use of paper in this country during the past half century has been an almost complete change in the purpose for which paper is used. Up until the beginning of the present century, paper on a tonnage basis was used most largely for printing and correspondence. To-day, from the standpoint of quantity used, printing and correspondence are secondary to the use of paper for wrapping, for shipment of commodities, for construction, and as materials entering into the manufacture of other commodities.

There is not only a paper for every use imaginable but in an increasing way the paper manufacturers are educating the consumers of paper to the fact that there is a right paper for the right use. In other words, there has been no great progress in the attitude of the manufacturer toward the proper use of his commodity. He is not interested merely in seeing more paper used but rather he is seeking to so educate the consumer that discrimination will be used in the paper to be consumed. This attitude of the manufacturer has led the larger consumers, in particular, to develop specifications and, where the quantity of paper justifies, to employ men who understand paper as purchasing agents. The scientific bureaus of the government have assisted greatly in developing this sense on the part of the consumer of the right paper for the right use. For instance, there is no advantage to either the manufacturer or the consumer to use a high-grade rag-content paper, the life of which, where it is properly made and used, may be more than a hundred years, for an article that may be used for a year or two or more only and then thrown away. It is of no particular advantage to the fire insurance companies, for instance, to use a paper whose life may be a hundred years, when the life of the fire insurance policy is three years.

There are still, of course, a few paper manufacturers whose only interest is to turn out the largest amount of paper and

who have no interest in its use. However, an increasing number of the paper mills have their own research departments and these are not only seeking to improve the technique in the mill and bring about the technical control of all operations but, through these research departments, are seeking to determine the best use for their papers. Such an effort results naturally in the production of better papers and there must follow the development of a service to the consumer that goes far in insuring continuity of demand and the most satisfactory business relations.

As rule-of-thumb methods have been used for so many years in the manufacture of pulp and paper in this country, and as art has always entered into the laying of the paper into a sheet and its final finishing for the market, standardization in methods of manufacture have come very slowly in the industry. The various pulps produced from different tree species and by different mills vary so in quality and character, and such delicate manipulation is necessary in bleaching and coloring the paper, that it is a very difficult matter indeed to standardize to the extent of saying that just so much pulp, bleached in a certain way, with the addition of a certain amount of filler, of sizing, and of coloring matter, will produce a certain grade of paper. However, slow development of technical control, through the work of the engineer and the chemist, has brought about a great deal of progress in the direction of standardization in manufacture. The art of the craftsman must always enter into the process of producing both pulp and paper and, therefore, it is doubtful if complete standardization in manufacture will ever be achieved, particularly with the higher grades of paper. In the lower grades of paper, where the process is simpler, it is quite within reason to expect that standardization will be carried much further than is apparently possible to-day.

Standardization in form or size of sheet, in color, and in finish, is an entirely different matter from standardization in manufacture. After several years of effort toward standardization in size and color, particularly, the paper manufacturer has come to feel that standardization would be advantageous to

him, but he has also come to feel that standardization must begin with the consumer rather than with the manufacturer. Unfortunately, the largest consumer of paper in the country, that is, the United States Government, though greatly interested in the extension of standardization in industry, is apparently less interested in the standardization of the papers which it uses than are business men in their use of paper. So long as the larger consumer specifies odd sizes and unusual colors and in such quantities as to justify the paper manufacturer in making the necessary run he is naturally going to continue to make what the consumer wants. But some progress is being made. Gradually the number of sheets to the ream is being standardized. The printer is learning that certain sizes simplify his problem of computation and he, therefore, calls for these standard sizes in preference to the odd or unusual sizes. Each year or each period sees some advance made, but for reasons outlined standardization generally will come more slowly in the paper industry than in other larger industries.

X

A CENTURY OF PROGRESS IN THE PRINTING INDUSTRY

By Ernest Frederick Eilert, M.A., D.C.S.
Past President, United Typothetæ of America

THE aeroplane and the radio come first to the mind when the progress of the last century is in question, but each industry in our modern busy industrial system can point to achievements as wonderful in its own field. From the little hand press of early printing days to the great rotary press which feeds from huge rolls of paper and turns out our modern newspaper completely printed and folded, and our periodicals printed, with color inserts, folded, and stitched and covered, at the rate of many thousands an hour, is a long technical journey.

The print shop of 1825, if it was very up to date, had just gotten in one of the new iron Columbian presses, which used leverage for the impression and was capped by an American eagle as the last counterweight in a series of levers. If not so flourishing, the print shop of that day was still using a wooden screw press, of a kind which seems to have been first suggested by cheese and wine presses of earlier times. In any case the principal remaining equipment of the shop consisted of some fonts of type, an imposing stone topped by a slab supplied by the local tombstone maker, and a trough of water for dipping the paper, which had to be printed wet. The presses could be depended on to register within half an inch or so, and vigorous work on the part of the printer or his apprentice produced as high as two hundred and fifty impressions an hour.

Now we have not only the great printing plant with rows of

high-powered presses and machines to perform every part of the process from setting the type to folding and binding the finished product, but we have a group of plants to perform processes unknown in the day of the printer of 1825. Where the print shop then was established usually to print a little local newspaper and then took in such incidental job work as presented itself, the newspaper industry and the commercial printing industry are now two great separate branches of the industry; and new processes have given rise to other industrial groups, namely, photo-engraving, lithographing, electrotyping, all large enough to have separate figures given for them in the U. S. Census of Manufactures.

The growth of the printing industry from the earliest date for which we have reliable figures, is shown in the following tables:

PRINTING AND PUBLISHING, BOOK AND JOB

Year	*Number of Establishments*	*Wage Earners Average Number*	*Value of Products*	*Value Added by Manufacture*
1869	960	17,613	$41,076,000	$25,185,000
1889	4,125	50,399	93,909,000	64,407,000
1899	6,919	67,610	121,798,000	85,606,000
1909	10,708	108,687	250,926,000	173,275,000
1919	13,089	123,005	597,663,000	386,596,000
1925 *	10,322	133,316	806,887,417	578,197,553

PRINTING AND PUBLISHING, NEWSPAPERS AND PERIODICALS

Year	*Number of Establishments*	*Wage Earners Average Number*	*Value of Products*	*Value Added by Manufacture*
1869	1,199	13,130	$25,393,000	$16,683,000
1889	12,362	85,975	179,860,000	140,905,000
1899	15,305	94,604	222,984,000	172,769,000
1909	18,871	108,672	406,090,000	308,730,000

Year	*Number of Establishments*	*Wage Earners Average Number*	*Value of Products*	*Value Added by Manufacture*
1919	17,362	120,381	924,153,000	623,768,000
1925 *	10,620	117,002	1,447,661,177	1,068,120,575

* Figures for 1925 excluded establishments of $5,000 and less annual product.

The new crafts which have grown up in the field have also shown development. Lithographing, which was invented only a little more than a century ago, has grown from an annual product of $2,516,000 in 1869 to $98,721,000 in 1925. Photo-engraving showed an annual product of $2,072,000 in 1889, the first year it appeared in the Census; in 1925 the photo-engraving, not done in printing plants but in separate photo-engraving establishments, amounted to $58,640,000. Stereotyping and electrotyping first appear in the Census in 1859 with a product of only $286,000. In 1925 the amount of this work done in separate establishments was $22,361,000, and this is a very low figure owing to the fact that the great bulk of stereotyping is done in newspaper plants and therefore not counted separately under its own heading. Bookbinding also has become to a considerable extent a separate industry and has increased from an annual product of about $3,000,000 in 1849 to $81,600,000 in 1925. The printing and publishing of music as a separate branch of the industry has increased from a product of about $1,700,000 in 1889 to over $15,000,000 in 1925.

With the invention of movable types the art of printing came into existence centuries ago and type setting is still the central process of the industry. As Henry L. Bullen has phrased it, "With type faces we create; all else in printing plants merely reproduces." Methods of type setting remained much the same for over four hundred years and it remained for the nineteenth and twentieth centuries to revolutionize this process as they have every other phase of the industry. The change has come in three ways—in the manufacture of the type itself, in the inventions of type-setting and type-casting machines, and in

the perfection of various aids for use in the work of the composing room.

After metal types began to be used and until well into the nineteenth century, types were cast from matrices in small hand molds, the output from which with a skillful worker was about four hundred letters an hour. This process of manufacture involved the hand cutting of steel punches for each character. These punches were then driven into slabs of copper called stripes or drives, to make the matrices. The cutting of the punches was very expensive, as it had to be done by highly expert men and the issuing of a new type face was a rare event. Not until 1838, in America, was a successful type-casting machine invented. This increased the rate of production to about one hundred a minute but these were not finished type and had to have several operations performed on them by hand to make them usable. This machine remained a standard appliance until a machine to produce the finished type was invented in Cincinnati in 1888.

One of the great difficulties in the path of progress in type founding, and indeed an equal difficulty in the development of typography, was the variation in types of the different foundries, each foundry having its own peculiar system of bodies. The development of the American point system of type bodies and its formal adoption by the Type Founders Association in 1885, was accordingly a great advance for the industry. Another important improvement was the use of accurate unit width of type in place of the old method of varying the width with each letter. This was followed by the systematizing of the lining or alignment of type. These improvements and the consequent standardization of type made possible the invention of the punch cutting or engraving machine, which does away with the steel punches and master types and engraves the character into a matrix direct. This is the method used in the modern type foundry.

All of these changes and inventions were thus far only in the production of the type itself, and as late as 1885 the compositor was still setting single type in exactly the same way as did his predecessor of four centuries ago. Unsuccessful at-

tempts to produce a machine which would set type began early in the nineteenth century in several countries. Among the machines which promised success was the Paige, the machine in which Mark Twain was so interested as to cause him to invest and lose over a quarter of a million dollars. It was a beautiful mechanism and its failure came from the fact that it was too complicated and could be used only by highly skilled mechanics.

The composing machines which were first invented were actual type-setting machines in that they composed foundry type. Justification of lines was made by hand, but distribution was also performed by mechanical means. Then the idea arose of avoiding the necessity for distribution by including in the machine the process of typecasting, and in 1884 the first model of this kind of machine was invented by Ottmar Mergenthaler, a German instrument maker who had come like many other Europeans to this country to avoid military service. The first successful machine was completed in 1886 and was at once put into the composing room of the *New York Tribune* through the interest of Whitelaw Reid, then the editor of that paper. The machine was named the Linotype by its inventor because it cast each line of type in a solid bar, justification of the type being automatic. The linotype was eagerly taken on by newspapers and periodical printers whose work demands speed in type setting, and by 1900 practically every newspaper of any size in the country was equipped with one or more of these machines.

While Mergenthaler was at work, Tolbert Lanston was experimenting on a machine which would cast type and spaces separately and at the same time arrange them in galleys ready for taking proof. This work resulted in the machine called the Monotype, because it casts single type. This has the advantage of allowing corrections to be made without remaking a whole line, and is also adapted to tabular and certain other kinds of work. The type which it produces can be distributed and re-used for hand composition although not quite so perfect as foundry type.

The Intertype and the Typograph are successful machines

developed from the utilization of the basic principle of casting a line of letters on one metal slug. The Ludlow is a type-casting machine in which the matrices are set and distributed by hand, and is especially useful for casting large-sized type and other kinds of display work. It is a non-distribution system so far as type is concerned.

In recent years there has been great improvement in the equipment of composing rooms, both newspaper and commercial. Steel equipment of various kinds, register and line-up tables, and scientific arrangement of equipment and routing of work, are all available.

A notable amount of progress has been made in the amount of attention paid to type design and artistic typography. The development of the best modern type design began under the influence of William Morris and has been promoted largely by the careful research work and expert layout service of the American Type Founders Company, the Mergenthaler Linotype Company, the Lanston Monotype Company, and other type founders and type-casting machine companies. The outstanding beneficial idea of the last quarter century in this field was the development of "type families" by the American Type Founders Company. This has done more than any other factor to impart harmony, with all needed degrees of emphasis, in American type composition. The type designs of Frederic W. Goudy, the only man in America working at type designing as a profession independently of the type foundries, form also a notable contribution to good typography.

The need for some method of reproducing the whole type page has given rise to processes which now constitute an important branch of the industry. This need early arose in the case of much-used books, such as the Bible. To keep the entire Bible standing in type for reprinting meant a great expense in the accumulation of type and a great risk in the handling of pages, each composed of thousands of separate pieces. Numerous experiments were made in casting molds of type pages in order to secure a duplicate printing form in a single piece, and various materials were used to take the impression, plaster-of-Paris giving the best results. The process was called stereo-

typing from the Greek word stereos, meaning solid. It was introduced into the United States in 1813 and the first book stereotyped in this country was the New Testament, in 1814.

The plaster mold was not entirely satisfactory and finally in France about the middle of the nineteenth century, the method of making the mold of papier-mâché was invented. This had the great advantages of being flexible so that a curved plate could be made and of rendering it possible to make a number of casts in succession from the same mold or matrix. The curved stereotypes solved the problem of the rotary printing form and thus were an essential part of the development of rotary and web presses. Further improvements have come, beginning about 1890, in the perfection of various machines for use in the process, especially a matrix-rolling machine, a matrix-drying press, a metal furnace with pumps and molds for casting curved plates, a machine for shaving the inside of stereotype plates to uniform thickness, and an automatic stereotype-casting machine. Experimenting on the production of the matrix is still going on, and it would appear that almost every known plastic substance which would withstand the effect of melted hot metal for casting has been tried for making the matrix, but papier-mâché is still in use in the greater proportion of stereotyping work, that is, that done in newspaper plants.

Stereotyping is the quickest method of producing a duplicate plate from an original molding form. After a type page is locked up it can be molded, the matrix dried, and the plate cast and ready for the press in from five to ten minutes. This is the reason for its prevalent use in newspaper work. It has, however, serious disadvantages for other uses where speed is not the first consideration. The metal usually used for stereotype plates is largely made up of lead and gives a relatively soft, quickly worn, printing face, and the stereotype is not adapted for reproducing the finest lines of type faces and engravings. This kind of reproduction is best done by electrotypes, steel faced from lead molds.

When in 1799 Volta invented the galvanic battery, the foundation for electrotyping was laid. It was over forty years,

however, before the first inventions came in this field. It was discovered, probably more or less by accident, that when copper was deposited upon the side of a Voltaic battery it formed a replica of the surface on which it was deposited. Joseph A. Adams, a wood engraver for Harper & Brothers, conceived the idea of applying this process to the printing industry and made an "electrotype" from a wood-cut which was used for a magazine illustration in 1841. He also made the illustrations for Harper's great family Bible, which was published in 1842-44. Adams' method was to take an impression of his block in an alloy of soft metal, probably largely bismuth. The process, however, destroyed the wood cut and so was not commercially practicable. In 1840 a battery was invented, especially adapted for electrotyping and at about the same time the use of beeswax for molds and a coating of black lead or graphite on the surface of these molds came into use. Using all these improvements, John W. Wilcox, of Boston, began business in 1848 as the first commercial electrotyper and within two months he had in use every essential known in electrotyping for many years following. One of the greatest forward steps in this field was made when the plating dynamo was invented in 1872. This dynamo and its improvements have shortened very much the time of plating, an essential feature of the commercial success of the method. The invention of the half-tone and the invention of the modern two-revolution cylinder press made necessary radical improvements in the machinery for making electrotype plates. All of these changes have looked towards the quickening and perfecting of the process, the fundamentals of which remain practically those now in use for many years. The electrotype is now the accepted method of duplicating indefinitely for innumerable printings at different times and places. If a million copies of a circular are to be printed from the one original type form, as many electros as desired may be produced to start any number of presses on the job or permit several to be printed at one impression on large sheets. The highest grade engravings can be expertly reproduced and since nickel facings have been used it is possible to make electroplates so durable

that they will stand up under the longest runs. The curved electrotype is used on magazine presses and has made possible the beautifully illustrated periodical of large circulation.

Reproduction of the type page has thus been provided for, but there was almost equal need for methods of reproducing pictures and illustrations to go with the type. The only provision for this during all the early history of printing was the wood cut, and indeed until the last quarter of the nineteenth century, line reproduction was the only possibility. The engraver rendered the subject on a wooden block. Such engravings varied largely with the artistic ability of the engraver and they were slow to produce.

It remained for the discovery of the processes of photography to change this whole field of the printing industry and to give us all our modern "process" printing, that is photomechanical reproduction of illustrations. It has thus come about that the last quarter of the nineteenth century witnessed the dispossession of the hand engraver and the occupation of his position by the chemist and the mechanician. The history of the development of these processes is so closely related to the history of photography that it scarcely belongs in the scope of an article on printing. The result of this development is that we have three general types of processes—relief, intaglio, and planographic. The relief processes gave us the half tone, made possible by the invention of the screen, and its important development, color process work. Color process reproduces by means of relief blocks, and it was in America that the first three-color blocks for letter-press printing were made, by F. E. Ives of Philadelphia in 1881. Great improvements have been made in this process in recent years, so that it is now possible to secure a high degree of accuracy in register and artistic color effects.

The intaglio processes are those in which the printing surface is sunk below the surrounding portions, as in the old-fashioned steel engraving. These processes have given us photogravure, an excellent but costly method to employ for illustrations. Recently the photogravure process has found a new application in the form of the method known as rotary photogravure or

rotogravure. In this process an intaglio photo-engraving instead of being produced on a flat plate to be printed from by the slow method of the copper-plate or steel-plate press, is engraved by the cross-line method on a copper cylinder and printed by the rotary press. This process is available where large editions are to be printed and is in use mainly for illustrated periodicals of large circulation and for pictorial supplements to daily newspapers. The presses in use to-day on this process are of the web type and run at a speed of 2,500 to 3,000 impressions an hour.

Planographic processes are those printed from a flat surface, and lithography with its flat stone or plate is the usual form employed. The principle of lithography was used all during the century but photo-lithography is now the usual process, and the drawing is placed on the stone or plate by a photographic process instead of by hand drawing. Perhaps the most important development in this field is that known as offset printing. It consists in first taking the impression from the lithographic plate on a rubber blanket and then upon the paper or other surface. The elasticity of the rubber blanket makes it possible to secure impressions upon rough surfaces not otherwise printable, and also produces very soft and beautiful effects in color printing.

Next in importance to the preparation of the type set in the desired order, or plates made from such type or from illustrations, comes the method of securing an impression from these plates or type. While it is not certain how the first printers struck off their copies there seems no doubt that Gutenberg did use a mechanical press of some kind and wooden hand presses on the screw principle were in use for a period of three hundred and fifty years. The first use of iron in making presses was towards the close of the eighteenth century in the Stanhope press invented by Lord Stanhope in England, and this invention marks the beginning of the wonderful improvements in printing machinery which were to go so far in the course of a century.

The Stanhope press was never brought to America because an American invented an iron press at about the same time.

George Clymer of Philadelphia, after much experimenting, produced the Columbian Press, an iron machine which came into general use in England as well as in the United States about 1816. Clymer christened his press in honor of his country and surmounted it with an American eagle. The press was a durable and powerful machine with great possibilities for the production of perfect work. Other hand presses along simpler lines were put on the market during the early years of the century, among them the Washington press, which is still in common use. Owing to the fact that the hand press admits of an unlimited dwell on the impression so that the ink incorporates itself with the surface of the paper, it has held its place as the ideal proof-press where fine impressions are desired.

The two great drawbacks to the hand press were its lack of speed and the fact that for many years it required the form to be inked by hand. This was first done by means of leather-faced balls made by securing specially prepared sheepskin to the handle in such a way that the wool was inside and made the padding of the ball. The rapidity and evenness with which the skillful pressman could ink the form with these balls was surprising. The first attempt to simplify the inking was by means of leather rollers. This was not successful but suggested the next invention, the composition roller made in 1813. These rollers were made at first of glue and molasses and later improved by the addition of glycerin, or its use instead of the sugar syrup. Soon it was found that two rollers used together in the same frame gave better ink distribution and this was followed by the arrangement of a vibrating cylinder upon which the rollers were distributed so as to ink the form as it passes back and forth. Later this apparatus was remodeled so as to be run by power and be automatic in its action.

From the time of the Columbian press the line of development has been the use of power driven instead of hand presses and the development of the cylinder press. As the printing and publishing business grew in importance, more presses were needed and greater speed in the work. Naturally as this was the age of the application of power to machines the attempt

was soon made to obtain a power-driven printing press. This first attempt was made in America by Nathan Hale, famous father of a famous son, Edward Everett Hale. The early power presses were worked by horses, by men known as crank-men, and even in the case of small machines by dogs. These crude appliances soon gave way to steam and eventually steam was supplanted by the electric drive, this last being an American invention.

The first really practicable power press in America was the Adams press, built in Boston about 1830. In this press the platen was stationary and the bed rose to meet it for the impression and dropped back again while the inking rollers passed over the form. This press in improved form enabled Harper Bros. of New York to revolutionize the printing of illustrated books in America. It gave excellent register and produced about 750 impressions an hour. For book work the Adams press was succeeded only by the cylinder press. In smaller sizes it was used for job work but was not so successful in this field. The real pioneers in the "job press," or small press built to do what is called job work, i.e., small circulars, cards, bills, blanks, and the like, were the Ruggles presses. These were succeeded by a series of presses designed by George P. Gordon and by the Universal press and its various adaptations. These two types of presses are still in use. The purpose in building the first job presses was to secure a small, quick, economical press. Most of them were made with the bed hinged to the platen just below the lower edge, producing what is known as the clam-shell method of impression. This had to be readjusted with every change in the thickness of the form because of its wedge shape; otherwise the lower part of the print would get a heavier impression than the upper. Mr. Gordon, in using this type of construction, improved it by dropping the hinge as low as possible, and reduced the imperfection so greatly that a series of presses were developed from the early Gordons and are still in use.

The ideal, however, was always the parallel impression or the kind given by two flat surfaces approaching each other with a parallel movement, as in the original hand presses. The

Adams press had the parallel impression but its drawback was the immense power required for lifting the bed. In 1869 Merrit Gally of Rochester made a great forward step in the designing of platen presses when he invented the machine called the Universal press. The machine was in a class by itself and the name Universal has come to designate any press giving a perfectly parallel impression in a similar manner. The Universal type of machine is the one used to-day for heavy job work requiring exact register. There are also adaptations of both the Universal and Gordon general principles for various special uses, such as ticket presses, embossing, cutting and creasing, dieing out of advertising novelties, stamping of badges, and so forth. Some of the special presses belong to the Golding series, the original Golding being a platen press with the clam-shell movement but differing from the Gordon type in several important mechanical adjustments.

The pressure for production again brought a further development. When attempts were made to construct platen presses so as to permit of their being run faster, a point was reached when they were capable of greater speed than the human feeder's ability to supply sheets. This meant that a mechanical or automatic feeder must be made a part of the press and this led to an entirely new series of machines. As early as 1870 Mr. Gordon devised a self-feeding platen press for small cards or tickets, which he named the "Firefly." Neither this press nor the next invention of a similar kind, the early Kidder press, remained long in use. The first really successful automatic press for general job work was the Harris Rotary press produced about 1890 and first shown at the American Institute Fair in New York. A number of other automatic-fed presses have since been developed, as well as separate mechanical feeders which may be attached to platen presses, and these are all in very general use.

During practically the entire period of the development of platen presses, an entirely different kind of press was being developed and perfected. The three general forms of printing presses are distinguished by their method of securing the impression. The platen press has the type form on a flat bed

and gives the impression by a flat platen. The cylinder press has the form on a flat bed and gives the impression by a cylinder. The rotary press has the form curved around a cylinder, the impression being given by another cylinder. An important variation of the rotary is the web press in which the paper is fed from a roll continuously instead of in separate sheets.

The desire for rapid production was again the motive which led to inventions in this field. There is also, however, another important difference between the cylinder and the platen press, that is the limitation of the size of the sheet which the platen can be built to take. The platen press squeezes the whole form at once and an increase in the size of the form means a great increase in the amount of power required to produce the necessary pressure. The cylinder press applies pressure only to a narrow surface across the entire form in the process of continuous revolution.

The first cylinder press was built in London and was used by the *London Times* in 1814 in its effort to supply the public with news of the Napoleonic wars. The first cylinder press in America was imported from London about 1826 and within a few years an improved form of it was being produced by Robert Hoe, with whose name the development of the cylinder press in this country is largely connected. For many years the cylinder press was used mainly for newspaper work, and book and periodical work of better grade was done on the power platen press. As improvements were made in the cylinder press it gradually displaced the platen machines on all work requiring size, quantity, or rapid production.

Many forms of the cylinder press have been built and then have gone out of use. There are now practically only two kinds, the single revolution or "drum cylinder," and the two-revolution press, the cylinder of which makes two revolutions for each impression, and of these two kinds only the latter is now in general use.

The single revolution press has a large impression cylinder which revolves once for each printed sheet delivered. Only half of the cylinder can be used for the impression, as half of the revolution goes on while the form is passing back

under it without touching it to resume its original position and thus be ready for another impression. Every inch added to the form therefore added two inches to the cylinder's circumference and cylinders became large and clumsy as builders tried to meet the demand for larger sheet capacity. In a two-revolution press the cylinder prints while making one revolution and is lifted during the second revolution so as to permit the form to make its return journey. Thus the cylinder need be only one-half the circumference of that on the single revolution press and therefore only one-fourth as heavy. Moreover, a smaller cylinder has a sharper curve and this prints a narrower surface at any one instant, giving a larger sheet capacity.

Further developments of the cylinder press idea are the perfecting press, which prints both sides of the sheet as it passes through the press; and the two-color press, which prints two colors on the same side of the sheet.

The early cylinder presses were of rather light construction and when the development of the half-tone illustration began to demand dry paper printing on a hard surface, these cylinders were not strongly enough built to do the work. The Huber and Miehle press builders were among the first to recognize this change and the Miehle, being the faster press of the two, forged ahead and finally absorbed the Huber Company.

Late in the nineteenth century the offset press, in which the lithographic impression is taken first on a rubber blanket, was put on the market. These presses are now built by several of the leading companies as the offset process is coming into wide use.

The last word in speed of operation is the rotary press. William Bullock of Philadelphia must be given the credit for the invention of this type of press. The simplest form of rotary press is the sheet feed, which prints previously cut sheets of paper one side at a time. It has the great advantage over a flat-bed press that it has a cylinder to rotate instead of a heavy bed and form to drive back and forth. On newspaper presses the plates which are fastened around the plate cylinder are stereotypes, on magazine and other high class work they are usually electrotypes.

In 1847 Hoe & Company began work on a rotary press to print from a web or roll of paper without first cutting it into sheets. The experiment was successful and resulted finally in recent years in the wonderful multiple press of the modern great newspaper. These presses have mechanisms for printing both sides of the sheet, for color printing, and for cutting, folding, and pasting or stitching. They are now built up in units to get more variety in number of pages and sometimes two or more folders are provided so that the product may all go into one many-paged paper. A further development is the "all-size web." This press prints from the roll, cuts the paper into sheets of various sizes, and prints and delivers complete units.

A recently developed color process known as the McKee Process is a treatment which raises the solids and drops the highlights in the electrotype plates. This is done by overlays provided for the purpose on both the front and back of the plate, which is then placed in a hydraulic press to secure the desired effect. This process eliminates the necessity of building up a make-ready in the packing. Necessary make-ready is placed underneath the plate and four wet colors are printed at each impression.

Automatic feeders adjustable to practically every type of press and various forms of delivery of the printed sheet aid in the rapid work of the press room.

An interesting recent development in the printing-press field is that of the automatic job cylinder. These are of three types, the Kelly, the Miller High-Speed and the Miehle Vertical. They are simply cylinder presses of small size and with the automatic feeder as an integral part of the machine. The development of these presses shows that the pressure for speed and for cheaper unit production has penetrated into the last stronghold of the commercial printer, the small job work.

It is not possible to discuss in detail all of the improvements that have been made in press-room processes, materials, and equipment. Progress has come in the production of inks of many kinds and greatly improved qualities, of better rollers, in the invention of precision plates, of metal bases, of mechanical overlay, and in various devices for air conditioning both as

to heat and humidity so that paper is kept in the best condition for printing.

Progress in the bindery has come especially in the latter part of the century. Up to 1880 nearly all binding processes were done by hand. While artistic binding still uses the old hand methods, commercial work is now turned out by a variety of machines, notably cutting, folding and gathering machines. Inserting, wire stitching, sewing, covering or casing-in, gluing-up, embossing and stamping are now all done by machines.

All of these improvements in machinery have naturally been accompanied by better planning and construction of printing plants so that the newer plants show a wonderful improvement in general sanitary and health conditions. A recent extensive survey conducted under the auspices of the U. S. Bureau of Labor showed that the printing industry has kept well abreast of the general improvement in public health in this country. Of the two traditionary diseases of the industry, lead poisoning and tuberculosis, lead poisoning has almost disappeared, and the decrease in the amount of tuberculosis has kept pace with the notable decline in the death rate from this cause in the population at large. Dr. Frederic L. Hoffman, who conducted this survey, was inclined to attribute a considerable part of the improvement in the health of printers to the shorter hours and better wages of modern times.

These better conditions may be attributed in part to the progress in the application of scientific methods in the industry and partly to the activities of the organizations of both employers and employees in the industry. Beginning with the early part of the nineteenth century the workers in the printing industry were organized in "typographical" unions and a little later the employers began to form associations which at first were mainly for price maintenance. About the middle of the century the various local unions of workers combined to organize the International Typographical Union, an organization which now has a membership of between seventy and eighty thousand composing-room employees in the United States and Canada. Towards the close of the century the increasing specialization of the printing industry was reflected in the forma-

tion of separate unions for the various crafts so that there are now the following international unions, each with a large number of locals: International Printing Pressmen and Assistants Union, with a membership of over 35,000; International Brotherhood of Bookbinders, with over 21,000 members; Amalgamated Lithographers of America, about 6,000 members; International Photo-Engravers Union, about 6,000 members; International Stereotypers and Electrotypers Union, about 6,000 members.

In the open-shop field the printing industry has produced some very interesting experiments in employee representation plans which cover a number of plants. There are three of these plans, the Graphic Arts Federation of Boston, the American Guild of Baltimore, and the Bookbinders Council of New York, the last named being confined to the binding industry. These plans were organized in 1921, as an indirect result of the national strike for the 44-hour week, and have accomplished some interesting results.

As among the workers so among the employers, specialization and the development of separate branches of the industry are reflected in the existence of a number of different associations. A great many employers' associations are local only and not affiliated with any national organization, so that a complete list of these associations cannot be given. The larger associations of national or international scope (i.e., including Canada and Mexico) are the United Typothetæ of America, the Employing Printers of America and the Southeastern Federation of Master Printers in the commercial printing industry; the American Newspaper Publishers Association, in the newspaper branch, and the National Publishers Association and the Periodical Publishers Association, in the periodical branch; the Employing Bookbinders of America, the American Photo-Engravers Association, the National Association of Employing Electrotypers, the National Association of Employing Lithographers, the Engraved Stationery Manufacturers Association and the Label Manufacturers National Association. An especially interesting organization in the industry is the International Association of Printing House Craftsmen. It is made

up of junior executives in printing plants and its purpose is expressed by its slogan "Share your knowledge."

Much valuable educational work in the industries involved is being carried on by these and other similar associations. The pioneer in this field was the United Typothetæ of America, organized in 1887. Although organized originally to meet a labor situation, this association very soon began to take an interest in educational work, especially in the fields of apprenticeship, and of cost-finding work. The degree of skill required of workers in this industry is very high and technical training has always been fostered and promoted by the United Typothetæ and its local groups in the various leading cities. Notable results of the many years of work of its Apprenticeship Committee, later called the Educational Committee, are a series of technical treatises on the various phases of the industry, now 41 in number; a complete plan of apprenticeship lessons, a large number of which are now worked out and in use in schools which teach printing; a series of courses for office workers in the industry which cover cost finding, estimating, proof reading, selling and advertising, especially worked out for printers; and a school for printing house executives which recently has been made a department of Carnegie Technical Institute and now gives a college degree. Typothetæ has also valuable alliances with New York University and Columbia University, and with public school systems in a number of cities.

Probably the most notable contribution made by any organization to the industry was made by the United Typothetæ in 1908, when it completed the work of a number of years by the publication of the Standard Cost-Finding System for Printers. As a made-to-order industry with a market largely local and with a great many small units in the industry, the printing industry is peculiarly subject to intense competition which can be kept within bounds only by the widespread use of the cost-finding system and its correlated science of accurate estimating. In this latter field the United Typothetæ again made a notable contribution to the industry by its publication in 1925 of the Average Production Records Book. The inter-

est of Typothetæ in cost work has been emulated by many of the associations in the allied crafts, each of which now has an adaptation of the Standard System for its own branch of the industry. In recent years Typothetæ and several of the other associations have given considerable attention to problems in the fields of Marketing and Plant Management. Considerable attention has been given to the subject of Marketing and a special training course for printing salesmen has been worked out in coöperation with an efficient organization which specializes in the application of educational principles to business problems.

Owing to the nature of the industry, scientific management methods are difficult to apply and require costly research study, but a few of the larger plants have made considerable progress in this general field. Technical research is carried on by the American Photo-Engravers Association and by the Lithographic Technical Foundation, an incorporated institution organized for research purposes by members of the Lithographers National Association.

The printing industry has developed two insurance companies of its own, the Graphic Arts Mutual Fire Insurance Company of Philadelphia, and the New York Printers and Bookbinders Mutual Insurance Company.

A century of progress in the printing crafts has seen the industry thus completely revolutionized in technique, machinery and business methods and the growth of a group of entirely new allied industries. The increasing dependence of our modern industrial system upon the printed word and the growth of education throughout the world with its dependence upon printing, augur a continuous progress for the printing industry in the century ahead.

XI

JOURNALISM AND PUBLISHING

By James W. Brown
Editor, "Editor and Publisher"

ONE hundred years ago journalism was on the verge of a revolution. Newspapers in the period which followed the merging of the British colonies into the United States were primarily weapons in the armory of those in government or those in opposition. Their editors were engaged in politics, or in the curious avenues of livelihood open to men with political connections. Journalism offered little opportunity for profitable use of capital and the barest of livings to writers. Advertising existed, but hardly more than that. The classified advertisements offered ships for charter, passage to Europe, whole or partial cargoes from ships just docked from distant lands. That was true in the seaports where most of the great journals, if such they can be called, flourished between 1776 and 1828. In the interior, the paid announcements were concerned largely with livestock, human and quadruped. In the large cities the price of newspapers automatically prevented their purchase by the working people, even if their heavy editorial style and their contents, edited from the viewpoint of the business man or politician, had not definitely limited their appeal. Street sales were unknown and the subscription price for the eleven daily newspapers of New York City was six cents per copy. It has been estimated that the average circulation of the most widely distributed New York papers was 1,700 copies daily.

The business men of the late twenties had begun to discover advertising. Their liner advertisements, illustrated quaintly with stock cuts of sturdy ships and barques, or of

curly-headed blacks, attracted the attention they desired. The patent medicine man and the practitioner who offered to cure "blood diseases" made their appearance in newspaper columns about this time. So did also the thinly disguised appeals of ladies following the oldest profession. But there was practically no advertising of retail merchants and absolutely none of what is to-day called national advertising. The advertising solicitor did not exist, for the newspapers of that day thought it beneath their dignity to seek revenue through that channel. They accepted what was offered, apparently without question or qualm, graced the tables of clubs and coffee houses, the desks of statesmen and the counting-rooms of merchants and speculators, and gave not a thought to the man and woman of *hoi polloi.*

New ideas were in the win, however. Shrewd publishers of the future were working at the printer's case in 1828 who were to lay a course for American journalism upon which it has gone far. Strange to say, it was not a printer but a physician, who issued the first penny paper. He was Dr. Christopher Columbus Conwell, an intellectual young Philadelphian, who started in that city, the birthplace of many journalistic innovations, a little penny paper which he called the *Cent.* He succumbed to cholera in 1832 and his paper died with him, but the idea survived. Similar efforts in New York and Boston during the next year were short-lived, but in the fall of 1833 the *Sun* was started by Benjamin H. Day, who had learned the printing trade in the office of the first Samuel Bowles of the *Springfield* (Mass.) *Republican.* In the terse style which marked this paper from its birth, Day announced at the top of the front page this ambition:

"The object of this paper is to lay before the public, at a price within the means of every one, all the news of the day, and at the same time offer an advantageous medium for advertisements."

The principal departure from the old régime was a half column of police court news, written flippantly and with a freedom that pales any liberty of present-day tabloids. While the established journals sniffed at this creation as one for

teamsters and servants, Day followed his chosen route and at the end of two months announced that the paper's success was assured. Within three years the *Sun* declared that its circulation averaged 27,000 copies daily, or 5,600 more than the combined sale of the eleven 6-cent papers. It had passed beyond the limits of teamster, servant and mechanic circulation and found an avid market for its news at all levels of society. Naturally the *Sun* had early competition. The *New York Herald* was soon a lusty rival and lived decades longer than any of the dozen other sheets which sprang to seize their share of the penny press fortune within the next fifteen years and with three exceptions died during that period.

To Day and the *Sun* belong the credit for the establishment of at least two great dailies in other cities which have come down through the century. Before he started the *Sun,* Day is said to have discussed his plan with two fellow printers, Arunah S. Abell and William M. Swain, both of whom ridiculed it but later joined its staff, Swain as foreman. Three years later, with another printer, Azariah H. Simmons, they conceived the idea of extending the penny paper idea to other cities and on March 25th, 1836, Swain, Abell and Simmons printed the first issue of the *Philadelphia Public Ledger.* Times were hard, with a panic near at hand, and the trio were close to surrender, when Abell, who had the greatest faith in the idea, went to Baltimore and established the *Sun* on May 17th, 1837. Swain remained as editor in Philadelphia, where the *Ledger* in 1838 took a strong stand for free speech and a free press during the abolition riots. Twice the office was mobbed, but Swain and Abell continued their partnership until 1864, when the *Ledger* was sold to George W. Childs.

Abell's editorship brought speedy results in Baltimore. In three months the *Sun* had a larger circulation than the Philadelphia paper had been able to obtain in nine months and in a little longer period it attained a circulation twice as large as the oldest established six-cent paper in Baltimore.

Antedating the *Sun* by almost three years, the *Boston Daily Evening Transcript* made a false start in July, 1830, and suspended until August 27th of that year, when it resumed pub-

lication, not as an actual penny paper, but offering the low annual subscription rate of $4.00. Its founder was Lynde M. Walter. The paper has had a long line of distinguished editors and contributors in its ninety-eight years of uninterrupted publication.

James Gordon Bennett, distinguished as a reporter, Washington correspondent and editor, was quick to sense the possibilities in the penny press, and on May 6th, 1835, he issued the first number of the *New York Herald*. He was his own reporter, copy-reader, editorial writer, solicitor, bookkeeper, and often circulator. His nose for news was extraordinary and his audacity was boundless. He attacked his competitors for speculation in Wall Street and attempted manipulation of the market through colored reports in their own papers. He made copy of the personal affairs of a former associate and when the latter laid in wait for him and beat him with a heavy stick, Bennett printed an account of the assault in the *Herald*. The paper sold 9,000 extra copies that day.

Paid correspondents were engaged in Washington, London and Paris, and this roster was increased when regular steam-packet service was instituted across the Atlantic. Bennett printed foreign news letters when the less energetic editors of the older dailies were content to let them wait for the next issue. As early as the second issue a Wall Street department was a part of the daily menu. Bennett developed a news bureau to serve the increasing number of papers in the interior, sending news-slips containing selected items free by pony express to reach subscribing editors a day ahead of the *Herald* itself. Subscribing papers paid for this primitive press association service by supplying the *Herald* with exclusive news from their own territories, an idea which was to be developed in later years into the Associated Press.

Bennett gave the city something entirely new, exploiting local, national and world news in manners which were wholly strange to a people served by the fifteen dailies, eleven semi-weeklies and thirty-one weeklies published in New York in 1835.

It is not the purpose of this writer to use his limited space

for long catalogues of newspapers published at various periods, but it may be of interest to note the names of the competition faced by the *Sun* and the *Herald* in their infant days. They included the *New York American,* the *Mercantile Advertiser* and *New York Advocate,* the *New York Daily Advertiser,* the *Morning Courier and Enquirer, New York Journal of Commerce, New York Commercial-Advertiser,* the *Business Reporter and Merchants' and Mechanics' Advertiser,* the *New York Times,* the *Evening Post,* the *Evening Star, The Man,* the *Jeffersonian,* the *New York Gazette and General Advertiser* and the *New York Transcript.*

The beginnings of modern circulation practice, as might be surmised, date from the advent of the penny papers, for the six-penny journals had disdained to seek sales in the street. The *Sun* was probably the first to sell its papers through newsboys, its early issues offering "liberal discounts to those who buy (papers) to sell again." Making the papers easy to read and then making them easy to buy are the two cardinal secrets of success realized by the penny pioneers.

These new journals were the first effective crusaders for reform of abuses in local government, which in the transition process from village to metropolis, often failed sadly. The *New York Sun* campaigned for a paid fire department to supplant the robust enthusiasm of the volunteer companies, which more often vented itself in street fights than in quenching of flames. The fire losses in New York and other cities during the middle decades of the nineteenth century were appalling and the *Sun* performed real service for the community when it won its fight for horse-drawn apparatus and a paid uniformed force. So did also the *Herald* in its successful campaign for a uniformed police force to replace the old "watch" whose only insignia, a tin star, could easily be removed if a gang fight or any other situation seemed beyond the powers of the officer, who then became an innocent bystander.

The third member of the triumvirate who was to earn undying fame in American journalism did not make his bid until 1841. Horace Greeley, perhaps the most picturesque figure

ever to grace metropolitan journalism, arrived in New York in 1831 and for ten years engaged in various ventures, among them the one-cent *Morning Post,* the first penny paper in the city, which foundered through lack of capital. He wrote for the *Daily Whig,* and in 1834 was also connected with a new daily, called the *New Yorker.* Four years later, in company with W. H. Seward and Thurlow Weed, he started a campaign paper in Albany, under the title of the *Jeffersonian.* In the Harrison and Tyler campaign in 1840, Greeley edited the *Log Cabin,* called "the best campaign paper ever published," by Henry J. Raymond, later editor of the *New York Times.*

Greeley failed to receive the political preferment to which he thought his campaign labors entitled him, and to that disappointment may be ascribed the founding of the *New York Tribune* on April 10th, 1841, as a penny paper, "removed alike from servile partisanship on the one hand and gagged, mincing neutrality on the other." It professed the Whig faith, and started life with 5,000 subscribers recruited from the editor's personal and political connections. The *Log Cabin* and the *New Yorker* were later merged with the *Tribune* and in 1842 the price was raised to nine cents a week, or two cents a copy.

If Bennett shunned the political arena, Greeley did not, and the already warm interest of the contemporary press in political affairs and speeches was further inflamed by the advent of the *Tribune.* It was in this era, before the invention of the telegraph, that the new trio of New York dailies engaged in stirring locomotive express races to get to the people first with the news.

Henry J. Raymond, when writing politics for the *Tribune,* scored one of the most remarkable beats of the day on a speech of Daniel Webster, delivered in Boston. Accompanied by a corps of expert compositors, Raymond installed a miniature printing plant on the night-boat leaving Boston, and although he knew no shorthand and most of his competitive reporters did, Raymond kept his printers busy with short "takes" of copy throughout the night. The speech was all in type when the boat landed and was met by employees of the *Tribune* at

5 o'clock the next morning. An hour later copies were on the street with a full report of the address delivered 200 miles away the preceding afternoon.

The *Sun* was probably the first paper to charter a locomotive as a news-transmission facility, and from 1842 to 1847 it is said to have spent more than $20,000 for this service. European mail-ships were often met at Boston by rival reporters for the *Sun, Tribune* and *Herald,* and on one occasion the *Sun* and the *Herald* had engines racing on parallel tracks to New York. The *Sun* man was first away and the *Herald* reporter, giving him a start, returned his own locomotive to the roundhouse and set his news as a special edition of the *Herald* on the presses of the *Boston Mail,* rushing the printed papers to New York. The *Sun* man, thinking the *Herald* engine had met with mishap, did not show his usual energy, nor did the composing room, and the *Herald's* edition reached New York streets first.

Mention should be made here of the establishment on October 26th, 1841, of the *Brooklyn Eagle* by Isaac Van Anden. Under the guns of the multitude of papers across the river, Van Anden set his price at three cents and there it has stayed for the better part of nine decades, holding its own with the largest dailies in the country to-day in volume of advertising and, like its contemporary, the *Boston Transcript,* deliberately keeping its circulation within tightly defined limits.

New York, of course, was the focus of the great journalistic development of this period, for the opening of the Erie Canal had added greatly to the city's commerce and the rising tide of German and Irish immigration was shortly to give it commanding lead as the nation's largest city. In other states and territories, however, the seed of journalism sprouted and bore some fruit which has endured through the century. Growth was handicapped by lack of machinery—when the *Sun* was started in New York, all presses were turned by manpower and the *Sun* was two years old when it introduced steam power to operate its flat-bed, double-cylinder Napier presses. Even then facilities were inadequate for the production of large editions of the four-page dailies. In the outlying

districts steam found its place even more slowly, for many papers in present-day metropolitan centers counted their circulations within the 200 mark. The *Chicago Tribune* was founded in 1847 by a group of which Joseph Medill finally stood forth as the master journalist, building a solid foundation for the giant which his descendants now in active editorial and business control style the "World's Greatest Newspaper." The *Chicago Daily Journal* appeared in 1844. In Milwaukee, the *Advertiser,* from which the present-day *Wisconsin News* traces its ancestry, was established in July, 1836, by D. H. Richards, who had the not wholly modern idea of advertising the attractions of the settlement and promoting immigration. The first daily newspaper published north of St. Louis and west of the Mississippi was the *Miner's Express,* established as the *Dubuque Visitor* in 1836 by John King. The daily edition appeared in August, 1851, and is the ancestor of the present *Telegraph-Journal* and *Times-Herald* of that city. The present *Burlington Hawk-Eye* began in 1836 as the *Mount Rose Western Adventurer* and the *Muscatine Journal* dates from October 27th, 1840. The *Fort Madison Courier,* still published, was established in July, 1841.

In Minnesota, the *Minnesota Pioneer* was established by James M. Goodhue, a native of New Hampshire, who has been described as the James Gordon Bennett of Minnesota. He established the paper in St. Paul (his original intention was to name it the *Epistle of St. Paul*) on April 28th, 1849, and until his death in 1852 he gave little peace to the fast-working gentry who sought to feather their nests before the law became too well established in the new territory. His paper, after many changes, is to-day the powerful *Dispatch and Pioneer-Press.*

From the same era dates the *Salt Lake City Deseret News,* founded by Brigham H. Young on June 15th, 1850. California had one or two newspapers prior to 1850, but its present group of journals all trace their origins to a period after the Vigilantes had tamed the fever of the early gold-rushers. In Oregon, the *Salem Oregon Statesman* dates to the early days of the territory and the *Weekly Oregonian* was established in Portland, December 4th, 1850, and its press was later used by

T. F. McElroy and J. W. Wiley to establish the *Columbian* at Olympia, Washington, in 1852.

Arizona first saw a newspaper in the form of the *Weekly Arizonian,* established at Tubac in 1859 by Sylvester Moury. Colorado's oldest paper is the *Denver Rocky Mountain News,* established in 1859, before the city which it served had yet been named. The *Boise Idaho Statesman,* still published under that title, dates its uninterrupted career from July 26th, 1864. The present *Cheyenne Leader and Wyoming State Tribune* traces back to 1867. Bill Nye's *Laramie Boomerang,* still published, was founded by him on March 17th, 1880. North Dakota, the last of the territories to get newspapers, saw its first when Col. Clement A. Lounsberry established the *Bismarck Tribune* on July 6th, 1873. Fargo had numerous journals between 1874 and 1894, when the *Fargo Forum* appeared and met successfully the obstacles which had proven too much for its predecessors. The *Grand Forks Herald* was founded in 1879 by George B. Winship.

While these seedlings were pushing their way to the sun in the wilderness, epoch-making ideas were taking form in New York and other Eastern cities. The Mexican War of 1845-1846 demonstrated the value of war as a circulation-builder and spelled the doom of the aristocratic journal. At the outset Northern papers found their war news in the columns of New Orleans papers, principally the *Picayune,* whose editor, George Wilkins Kendall, was at the front as his own correspondent. The news was often three weeks in reaching the seaboard cities and the delay led to the formation of a coöperative association to gather and transmit the war dispatches speedily. The *Baltimore Sun* had already arranged for its own exclusive pony express service overland from New Orleans, using sixty blooded horses to race the news across the mountains. Later the *Philadelphia Public Ledger* and the *New York Herald* became associated with the *Sun,* and the combination was recruited by the *New Orleans Crescent City.* The running time between New Orleans and Baltimore was six days, often beating the southern mail from New Orleans to

Washington and incurring the jealous displeasure of the post office department for the enterprising journals.

The telegraph also began to attract attention. Greeley early sensed the possibilities of the Morse invention, though he permitted the *Herald* to excel him in use of the new instrument. The Baltimore newspapers were the first to make regular use of wire transmission, using the line set up between Baltimore and Washington in 1844. All used the wires sparingly, not only through distrust of the precarious service, but because of the high cost.

The natural descendant of the telegraph, the press service, was slow in developing. Between 1830 and 1840 there were three coöperative groups in New York for the gathering of marine news. In 1856 the General News Association of the City of New York was organized. Gradually this association, known informally as the Associated Press of New York, extended its service to other cities and was a factor in the press association wars of the '80s and '90s out of which grew the present news service structures.

The fourth great paper of the new era in New York was the *Times,* founded by George S. Jones and Henry J. Raymond on September 18th, 1851. Raymond was deeply interested in politics, but did not think that editorial opinion was paramount. In its early successes, as well as that to come later under the management and ownership of Adolph S. Ochs, the *Times* made news its foundation. One of its early services was the exposing of a plot to give railroads entering Minnesota territory large tracts of land free. Four members of Congress were expelled as the result of the inquiry. Fifteen years later the *Times* exposed the Tweed Ring's grafting in New York. Raymond was successful in politics—far more so than Greeley—but his greatest journalistic success was achieved when he abjured the attractions of the political arena.

Greeley's great moment in politics came in 1860, when he gained revenge for many fancied and real grievances against his old associate Seward by swinging the Republican convention away from Seward to Abraham Lincoln, a story so well

known as to need no repetition. The Civil War was imminent and the one-time pioneer penny papers faced it with a strength never before seen in American journalism. The *Tribune* had 287,750 circulation counting daily and weekly editions together, the daily having about 55,000 average circulation per issue. The *Herald* had the largest daily circulation in the world, about 75,000 copies. The *Sun* circulated about 60,000 daily, the *Times* about 35,000 and the *Evening Post* 18,000 copies. Greeley was a few years later to write bitterly of the Administration's conduct of the war, but in 1861 the *Tribune's* battle cry "On to Richmond," has been held largely responsible for the premature effort of the undrilled Northern army to attack Virginia's capital, with resultant disaster at Bull Run.

The *Herald* had not warmed up to the war in 1861, and it used the Union army's rout as a whip with which to belabor the *Tribune*. The incessant pounding of Bennett's puissant daily roused mob fury against the *Tribune* and during the draft riots of July, 1863, the building was saved from total destruction only by the arrival of 100 policemen with orders to "take no prisoners." Hundreds of people were wounded and twenty-two were killed. The *Tribune* building the next day was a veritable arsenal. Greeley editorially announced that the paper was prepared for any encounter and afterwards claimed that his courageous stand marked the turning point of the war. There were no more riots. The *Times* also armed its office with a revolving cannon and distributed rifles to its staff. Editorially it denounced the rioters, urging the authorities to "give them grape and plenty of it."

At the front, war correspondents were permitted for the last time in a major war to transmit uncensored dispatches of operations, often to the discomfort of commanders in the field who found their dispositions and plans thus disclosed to the enemy. This freedom was modified by corps and army commanders later in the war, and military authority was often invoked to suppress Southern newspapers whose activities hampered Union movements. The Confederacy supplied Southern newspapers with war news through an official press association and it was seldom that Union generals found in them new

information of military value. Early efforts at censorship in Washington failed when the censor assumed the function of suppressing true news of defeat and substituting a victory version. Raymond of the *Times,* whose account of the batttle of Bull Run was "filed" in the waste-basket by the censor and replaced by a highly colored story of a Union victory, complained so strenuously at Washington that the primitive censor system was abandoned.

In their treatment of the soul-shaking events of the war, newspapers of both North and South followed the extremely conservative typography permitted by the mechanical facilities of the era. Headlines were seldom more than one column wide, because the breaking of a column-rule in the days when hand-set type was locked in curved chases to fit the Hoe cylinder press was a job requiring more trouble and pains than the result warranted. Except for the announcement of a great victory or defeat, the most important news of the day was the casualty list, usually set in fine type. News from the front carried some such headline as "The Great Rebellion," or "Important from Washington." Progress of the Civil War developed a high degree of military philosophy and acumen—to their own minds at least—in Greeley, Raymond and Bennett, and the volume of what in the current idiom is called "back-seat driving" that issued from these newspapers was tremendous and influential, not always for the best interests of the cause it sought to serve.

Mechanically, the war forced the metropolitan newspapers to the stereotyping process which had been successfully tried by the *London Times* in 1856, casting metal replicas not of entire pages, but of single columns, which were fastened to the press cylinders in much the same fashion as had been the type "turtles." The New York papers had known of the idea, but gave it no attention until the *Tribune,* in August, 1861, began making *papier-mâché* matrices of entire pages and casting curved leaden plates. The *Times* and the *Herald* soon followed and in their wake papers in other cities. It was no longer necessary to add additional cylinders to the press to increase the size of the paper. Any number of replicas could

be made from the matrix and the old-style printing press, cumbersome and slow, made way for the first web-perfecting press, printing at high speed from a roll of paper, in the late sixties.

Manufacture of newsprint paper from woodpulp was accomplished by Henry Pagenstecher in 1867, and the new cheap paper in a few years completely displaced the expensive rag stock upon which newspapers had previously been printed. The change made for quantity production.

With the close of the Civil War period newspapers had attained new levels of prosperity and the new mechanical processes promised rapid progress. The promise was not wholly fulfilled. Journalism fell into the ethical and economic doldrums that engulfed the rest of the country for the next thirty years and though there are many bright spots in the picture, there is little of the glamor that marked the beginning of the present hundred-year cycle.

Greeley retired as editor of the *Tribune* to run against Grant for the Presidency in 1872, and never again attained the journalistic heights that had been his for many years. The elder Bennett died in the same year and his son, the picturesque Commodore, took up the direction of the paper. He might have won equal rank with his father as a journalist, for in his hands the *Herald* reached its greatest heights, but his capricious mentality kept disrupted the organization which had worked together for so many years.

Charles Anderson Dana, who had resigned as managing editor of the *Tribune* in 1862 after a bitter disagreement with Greeley, served as Second Assistant Secretary of War until the close of the conflict, then became editor of the *Chicago Daily Republican,* returned to New York in 1867 discouraged by lack of funds and abundance of dissension among the owners of that paper. He intended to start a new daily in New York, when he was offered the *Sun* for $175,000. After January 25th, 1868, when Dana assumed control and announced that he would conduct the paper independent of all parties, the paper's tarnished halo shone with new luster. The scandals of the Grant administration felt the *Sun's* heat incessantly, and when the soldier president retired from his stormy post, Dana turned

his editorial rays upon the questionable methods which resulted in the election of Rutherford B. Hayes. But it was not on the editorial page that the *Sun* shone brightest. Newspaper men studied and loved Dana's *Sun* and still cherish the memory of the condensation, clearness, and point with which it told its news stories. It was a haven for the struggling poet and it had a literary charm that was peculiarly its own and has not come down to the present generation in any form.

After the death of Greeley in the winter of 1872, control of the paper passed to Whitelaw Reid. The Franco-Prussian War had given the *Tribune* an opportunity to apply the lessons gained during the Civil War and this paper's expenditures for correspondence from the battle-front during this brief conflict were well over $100,000, or about thrice the amount spent for that service by the *Tribune* and the *Times* combined during the turbulent days of 1863, which had seen the battles of Gettysburg and Vicksburg and the Emancipation Proclamation. It was a new and meritorious enterprise, but the credit that the *Tribune* should have received for it was lost in the applause won by the *Times* the following year for its exposé of the Tweed Tammany Ring which had looted the city treasury of untold millions. The low estate of many newspapers of the day is shown by the statement that 89 newspapers were on Tweed's payroll and that 27 of these, dependent wholly upon the proceeds of Tweed's plundering operations, were forced to suspend after the *Times* had uncovered the evil mélange. Of similar nature was the exposé of the Whisky Ring by the *St. Louis Democrat* in 1872 and 1873, bringing to light a conspiracy to defraud the government of revenue taxes on distilled liquors, with a side-dish of a slush fund to bribe government officials and silence the newspapers.

But while corruption was rife at Washington and in many cities, and economic conditions in the East brought small returns to capital and little more than poverty to the workingman, the winning of the West was proceeding. As the railroads advanced the frontier and the fighting red men retreated, the editor and his hatful of type and handpress moved ahead with the pioneers and soldiers. The South emerged slowly

from the pall of war and one by one its old newspapers which had been suppressed resumed publication and new journals sprang to being in the revived cities and towns. In the larger cities the latter half of the seventies saw the beginnings of modern trends in several outstanding journals of the present day, including the *Chicago Daily News, Philadelphia Record,* the *Philadelphia Bulletin* (originally established in 1847); the *Washington Star, Indianapolis News, Washington Post, San Francisco Examiner, San Francisco Post, Omaha Bee, Omaha World-Herald,* and *San Francisco Chronicle,* to mention only a few. The *Detroit News* had been established in 1873 by James E. Scripps and the *Louisville Courier-Journal* in 1868 had come under the direction of the petulant phrase-maker editor, Henry Watterson. Joseph Pulitzer was already a power in St. Louis with his *Post-Dispatch,* developing the theories that he was to put into practice on the *New York World* after he acquired it from Jay Gould in 1883.

Writers on journalistic philosophy are generally in accord in giving to Pulitzer credit for the great changes in the character of journalism that followed his advent. Unquestionably his was a new voice crying in a wilderness. The public service ideal upon which the press based its claim to freedom from governmental interference was honored and followed by the outstanding newspapers in many cities, but its gold was sadly debased by many publications whose morals were those of the corruptionists that infested governmental halls during the reconstruction era. Pulitzer made his foundation for the *World* the public service, heedful neither of "predatory plutocracy nor predatory poverty." His methods compelled people to read his paper and his force compelled action along the lines he advocated. The *World* editorial page has well been called the most distinguished in American journalism over several decades. A Democratic paper, it did not hesitate to disagree emphatically with Democratic policies when the public good so dictated.

The battle for supremacy a few years later between Hearst and Pulitzer in New York was the most spectacular in the history of the country, and undoubtedly has influenced the char-

acter of newspapers throughout the land, but it is this writer's opinion that a more subtle and more beneficent influence was wielded in the interior cities by several men whose history is yet to be written.

Among them stand Melville E. Stone and the late Victor F. Lawson. The former established the *Chicago Daily News* in 1875, and a few years later called Lawson as his associate. When Stone became general manager of the Associated Press during the eighties, Lawson became the principal owner and absolute director of the paper, which remained under his ownership until 1925 and supplied the fire from which many another publisher lit his torch in the forty intervening years. Lawson's idea, and Stone's, too, was an evening paper which should present the news as completely and in as finished a style as the morning journals, despite the latter's great time advantage. Their paper was generous, public-spirited, meticulous in the presentation of even trivial local news, and it won and has held with few lapses undisputed sway in the local evening circulation field.

Numerous great daily papers of the present day have shaped their methods upon those proven by Lawson. They include, among many others, the *Kansas City Star, Indianapolis News, Newark* (N. J.) *News, Philadelphia Evening Bulletin* and the *Washington Evening Star,* all of which are among the great newspaper properties of the present era.

Working along lines differing entirely from those of Lawson and Stone, and more nearly those of Pulitzer, was Edward Willis Scripps, the first of the great chain of publishers. Scripps began, with money borrowed from members of his family, publication of the *Penny Press* in Cleveland. His long career, extending back more than forty years from his death in 1926, is one of the most remarkable in journalistic annals. His papers were unmistakably and honestly edited for the workingman and his family. Liberal, human and humane, they placed the interest of the reader invariably before that of the advertiser. They suppressed no news for any consideration, even printing the item that their proprietor had been arrested for driving his horse and top-buggy at law-breaking speed

through city streets. Scripps demanded not only that his paper cherish ideals but that they make their ideals pay. He gave a young man a printing press, a case or two of type, a fistful of pennies, a free hand in a new city, and told him to make his own way. Usually they did, and Scripps received his regular annual profit from venture after venture instituted in this manner. It is related that Benjamin Franklin pursued similar policies with journalistically ambitious youngsters who sought his help.

Scripps held himself completely aloof from the reigning journalistic influences of his day. He refused membership in the Associated Press and established his own press association service, which grew into the present United Press Association. He established his own bank and financed old and new papers from his own central funds. He made his press association service available to any paper which had the money to pay for it, selling no memberships or rights of protest against the extension of service to a competitor.

His enterprises are entirely owned by employees and members of his family and have been since the days when his youthful missionaries started their zealous careers in cities which had not known a press made primarily for John Laborer. Few failures have attended their efforts and some of the ventures which failed enjoyed glorious lifetimes. Associated with Scripps for many years was Milton A. McRae, who handled the business and administrative affairs of the many enterprises. The group, numbering twenty-six daily newspapers, is now the Scripps-Howard Newspapers and is under the ownership of the employees and the management of Robert P. Scripps and Roy W. Howard, both young men. Their newspapers are now located in all parts of the country and the chain, in point of numbers, is the most extensive of the present day.

Pressing the Scripps-Howard Newspapers closely in number and surpassing all newspaper groups in point of circulation, is the chain owned by William Randolph Hearst, whose star flashed across the Eastern horizon in 1896, when he purchased the *New York Morning Journal* from Albert Pulitzer, a brother of Joseph Pulitzer. A contemporary described his

advent in New York as having been made with "all the discreet secrecy of a wooden-legged burglar having a fit on a tin roof," and there is no question that the city was soon aware of his presence. He brought with him the methods that had won readers and patronage for the *San Francisco Examiner,* which his father had given him ten years previously and proceeded to prove to New York publishers that "nothing succeeds like circulation." The best men in the employ of other papers were lured to the Hearst flag by fabulously large salaries. The Spanish-American War came along, hastened, some said, by Hearst and Pulitzer, and provoked a rivalry that for bitterness of recrimination and amounts of money spent for news service and promotion has never been surpassed. Both publishers had fertile brains and long purses and drew without stint upon them for years. When the clatter ceased and the smoke cleared away, the Hearst *Evening Journal* had attained the largest circulation of any evening paper in the United States and the *Evening World* of Pulitzer was as far ahead of the rest of the New York field as the *Journal* was ahead of it.

With New York established as an Eastern vantage-point, Hearst took his message to other cities. Editorials written by Arthur Brisbane, then and now the highest-salaried editorial writer in the country, cartoons and comics that crackled with new ideas, headlines that almost gave the reader a black eye with their forceful blows, human interest stories written with a "kick" that for sheer audacity had never been approached by contemporaries or antecedents—all of these marked the Hearst newspaper wherever the standard was set up. Invariably, or almost invariably, circulation followed. Not all of the Hearst newspapers have met immediate prosperity, but no paper that Hearst established has ever been suspended. Only one of the many that have come into his possession has ever been sold. In general, the Hearst newspapers have followed a sane, if sensational, course in municipal affairs and many of their national policies have been vindicated after years of advocacy by official and public approval. Their influence has been lessened, no doubt, by the lack of restraint and respect for current standards

of good taste with which they have attacked those who disagreed with them.

Simultaneously with Hearst's arrival, came one from the South who was to bring a new, or rather a clarified, version of the old relation of news and newspapers. He was Adolph S. Ochs, publisher of the *Chattanooga Times,* who in September of 1896, borrowed $75,000 and bought the *New York Times.* He found a paper holding with its last breaths to the tradition of Raymond, John Foord, and the spirit which had cleansed the city of the Tweed Ring, its life all but extinguished by years of unskilled direction. Ochs, already standing high among his colleagues, especially in the South, believed that the *Times* could be restored to its old vigor by reapplication of the first principle of journalism—news. Before the end of the first four-year period had placed him in complete financial control of the paper, he had established the slogan, "All the News That's Fit to Print" as an apt description of the *Times'* efforts. Surrounding himself with capable executives in all departments, some of them remaining from the old régime, he poured the greater part of the paper's growing income into the development of news sources around the world and into adequate equipment for getting the news to the public. Circulation grew without interruption and advertising followed.

With the rise of Ochs the present era in journalism begins to take recognizable form. The *Times'* publisher was in the newspaper business for the sake of the newspaper business, not for any possible political or social rewards. His course is that of most metropolitan editors and publishers of to-day.

The period from the advent of Ochs to the beginning of the World War saw some remarkable, if not revolutionary, developments in the newspaper profession or industry. The previous decade had seen the coming of the linotype machine, casting type in line-wide slugs rather than in individual characters, and giving one man the potential working capacity of six hand compositors. While this maximum capacity is seldom realized in daily operation, and the number of printers employed by the country's newspapers has increased rather than decreased since the adoption of machine composition, the en-

hanced productive ability of the composing room has been responsible, more than any other factor, for the great daily editions now placed before the public.

Refinements in stereotyping machinery and printing presses have been constant, all tending to increase the speed of newspaper operations and to eliminate lost motion and waste, but none of them has been as revolutionary in aspect as was the first press to permit the printing of newspapers from type forms curved to fit the cylinders, or the duplication made possible by the first stereotyping mechanism. No notable advances have been made in the process of producing paper from wood-pulp, speed being the principal object of refinements in this branch also.

Gathering and transmission of telegraphic news also accelerated its pace. Early in the present century the Associated Press was reorganized in its present mutual form, assembling at strategic points the news originating in the fields of its 1,200 members and in all parts of the world, editing the mass of data into an intelligible report and transmitting it in varying quantities to member papers. A few years later the United Press Associations arose from the merger of several old established press services, to be followed after a short interval by the Hearst News Service. The latter was established originally to serve the newspapers owned from coast to coast by William Randolph Hearst, but its scope was soon broadened to supply a world news service to all newspapers desiring it. This service is now known as the International News Service and serves evening papers. Morning newspapers owned by Hearst and other morning papers are served by the Universal Service. A more recent development was the organization, under the managing directorship of David Lawrence, of the Consolidated Press Association, with headquarters at Washington and New York and with a network of leased telegraph lines covering the country for the dissemination of spot news and feature material of an interpretative nature and also the intricate and complete tabulations of stock-market quotations, sports records, etc. These five furnish the bulk of foreign and domestic news, not of local origin, that appears in the daily newspapers of 1928.

Their telegraphic and cable service in recent years has been augmented by liberal use of the radio telegraph for reception of news at central points, and experiments have been conducted for several years by all of the services with a view to using radio for transmission of their reports to newspapers.

Paralleling the development of the wire services has been that of the syndicates, the first of which was established about 1883. Their purpose has been to make available to all newspapers at low cost the best obtainable feature material of all kinds. Interviews with world-famed personages, fiction by the world's best writers, cartoons and comic strips from the pens of foremost artists—the list could be made endless of the reading matter placed daily before the editors of the country at negligible cost by the more than one hundred syndicates now in operation. They have revolutionized the production of newspapers for the smallest and least affluent editor pays his few dollars a week for the same editorials, the same cartoons, the same comics, the same puzzles, and so forth, as the metropolitan daily prints after paying the artist or author money enough to ransom a prince. The syndicates place the day's feature news on the editor's desk with the aid of every facility of modern speed transmission. Airplanes rush from the scene of action to the field office with news and pictures. Replicas are hustled through editorial and molding rooms at express speed to fast trains, airplanes, telegraph and telephone wires, and the picture that is more than a day old is often useless for publication. In fact, the airplane is almost obsolete as an aid to speed in news and feature communications.

With the speed and greater production afforded by the new machinery newspaper advertising began during the eighties to draw away from the old and limited forms. Pictures had been used in newspaper advertising early in the century, wood cuts and an occasional steel engraving being the usual medium. When the type was changed from the flat form to the curved "turtle" to fit the new cylinder presses, the task of maintaining the solid columns of hand type in equilibrium was one which held the compositors almost in terror until each page was safely locked on the press. It was not so difficult if the rules dividing

the page into columns were solid units running from top to bottom of the page. It was hazardous if the rules were cut to admit advertising of more than one column in width or a block which had not been "justified" to the hair's breadth before inclusion in the page. The slightest variation, vertically or horizontally, in the column might pitch an entire page to the floor in a heap of utterly confused "pi." For that reason, cuts and advertising more than one column wide were not favored by publishers in the days of "turtle" forms and if they were accepted, the rate was made prohibitively high.

Not until the stereotype was well established did advertising display assume forms resembling modern ideas. Not until photo-engraving became commercially possible about forty years ago did cuts return to their old illustrative mission.

Local merchants and tradesmen have been the premier advertisers in newspapers through more of the country. From 50 to 60 per cent. of the advertising space in present-day newspapers is of that origin and until ten years ago it occupied a much larger proportion. Classified advertising is the lineal descendant of the only advertising that the journals of a century ago printed. It received its greatest impetus in the *New York World,* Pulitzer realizing the great circulation value, as well as revenue, inherent in advertising which gave people hitherto unrealized opportunities for earning their daily bread. Every large city now has at least one newspaper recognized as the local classified medium and the fluctuations of "help wanted" and "situations wanted" advertising form a reliable barometer of the condition of local business.

The other great element in newspaper advertising is that formerly known as "national" and now more commonly termed "general." At the close of the nineteenth century, much of what the newspapers called "national advertising" was placed by food and medical manufacturers. Competition was keen among newspapers for this advertising, even though it was usually bought by the manufacturer at less than the rates quoted by the publisher, and the copy itself would be refused under the high standards set by most newspapers to-day. The term "national" was a high-sounding misnomer, for not more

than half a dozen newspapers circulated in appreciable quantity beyond the immediate vicinity of their home cities. No magazine in 1900 had attained what even a generous geographer could call national distribution. Nevertheless the advertising in newspapers and magazines brought fabulous returns to the mail-order, food, beverage and medicine men who saw the possibilities of making every copy of every publication a salesman for their wares who was welcomed and not turned from the door. Modesty was not one of the principal qualities of these advertisers and truth was lightly held. They had been riding their advertising steed over golden roads for many years until early in the present century when the government began to attend to abuses of public confidence by business men. On the heels of the enactment of legislation regulating the food and drug industries came the rise of several magazines to circulations over or near the million circulation mark. The *Ladies' Home Journal, Saturday Evening Post,* Butterick Publications, *McClure's Magazine, McCall's Magazine,* the *Literary Digest,* and numerous others are survivors of the great magazine revival during the "muckraking" era, which dragged to the light the private sins of many in the public eye. Publications commanding attention in groups of a million, more or less, at once felt the necessity of increased advertising revenue. Here was the genesis of modern "national" advertising, but it was delayed for several years by the reluctance of manufacturers to place their virgin advertising messages beside the lurid copy devoted to selling patent medicines and cures.

In the "clean-up" which followed many well-known names disappeared for a time from magazine advertising columns, to come back later in wholly chaste garments. The process covered several years, and even to-day there are corners not yet reached by its light, but before it was well under way, the new advertisers were crowding the magazine columns with their announcements. By 1915, even prominent newspaper advertising men recognized the magazine as the premier national advertising medium. The clean-up process had touched the newspapers also, and they gradually eliminated copy which offended good taste or was obviously untruthful. They began

also in 1914 to promote ideas which had gained the favor of national advertisers as to verified circulation figures. Only a few newspapers had previously made regular, responsible and reliable statements of their circulation. The Audit Bureau of Circulations was established in 1914 to supply semi-annual audited statements of all newspapers and magazines subscribing to its services, which were directed by a group of advertisers, advertising agents and publishers. Two years previously, the Bourne Law had been enacted by Congress, compelling all publications to print semi-annual statements of their ownership and executive management, and commanding daily newspapers to give in addition their average daily net-paid circulation for the preceding half-year.

The results of these efforts, and of the successful newspaper campaign during the Taft administration to keep newsprint paper duty free awakened newspaper publishers to a new class consciousness. They saw this new national advertising in the magazines and desired it. The volume of this advertising was showing a rapid and steady increase, and while some of it was appearing in daily newspapers, the majority of advertisers preferred the magazines for their better printing, wider distribution, and generally more intellectual tone of editorial content. Neither the newspapers nor the advertising field had reached the stage of organization where one great group could address the other in understandable language, and the next great step was the perfection of the trade associations.

At this point, it may be well to introduce a few lines concerning the advertising agency, for this form of enterprise plays an essential part in events of the past fifteen years. The first advertising agencies were founded about half a century ago by gentlemen in New York, Chicago and other large cities who saw possibilities in newspaper advertising that were not revealed to most of the editors and publishers of that time. Their procedure generally was to buy space *en bloc* from a publisher, giving the newspaper or magazine a lump sum which was usually much less than the retail value of the space. They then visited manufacturers who were already advertising or who might be convinced that their business salvation depended

upon their counteracting a competitor's advertising, and sold so many thousand inches of the space committed to them by publishers. Their principal in those days was the publisher. Their organizations were composed in the main of salesmen and clerks, the latter to handle the not inconsiderable bookkeeping that grew up around this double-ended business. In same cases, the agent wrote the advertiser's copy.

Gradually publishers realized that their space was worth at least as much to themselves as it was to the advertising agent or his client advertiser, and the brokerage of space was stopped. Publishers and their advertising men visited the large cities periodically to call upon the great national advertisers and upon the advertising agencies which were beginning to turn their interest toward finding new advertisers and developing those already in the ranks into users of larger space. Newspapers and magazines offered inducements, in the form of commissions and discounts of varying proportions, to national advertisers and to advertising agencies, and the latter began to expand their services to provide the art work and alluring copy with the expert touch that the new idea demanded. They took into their organizations the men who had bought publication space for the early national advertisers and were familiar with the characteristics of newspapers and magazines throughout the country. At the beginning of the World War, there were about 1,000 advertising agencies of varying size, experience, resources and reliability, and publishers had long since seen the necessity of keeping cases on the firms through which they derived a considerable portion of their income. About 300 agencies were listed by the American Newspaper Publishers Association in 1914 as "recognized," which meant that they had passed the credit standards set by that body. It also meant that the publishers recognized the services of such agencies in the development of new advertisers and marked such recognition by the payment of the commission demanded by the agency upon the business placed with each publication. The standards demanded by the publishers are high and the association's rating is coveted by agencies, and accepted as a guide by associations of other publishers.

Organization of their own group by leaders in the agency business was not perfected until 1917, when the American Association of Advertising Agencies was formed. This group, both in a body and as individuals, have maintained high qualifications for membership and strict rules of business conduct for members. Since its organization the volume of national advertising in daily newspapers has increased from $100,000,000 to about $250,000,000, and the total volume of advertising which passes through the hands of the membership has also more than doubled. To-day, it is said that 90 per cent. of all national, or general, advertising is placed by the 150 members of this association. Losses to publishers through the failure or bankruptcy of an agency, which had been greatly reduced under the supervision of the publishers' association, have become practically negligible since the agencies' association, known to the craft as the Four A, required regular statements from its members of the condition of their business.

In the meantime the publishers' association had organized a bureau to inform national advertisers of the great advantages that were theirs if they concentrated their appropriations in localities where their wares were handled by retail dealers, rather than diffuse them in media of national circulation. Both the buyers and the sellers of advertising space had reached the point where group could talk to group. Newspaper publishers began to think in the terms of the markets they served and to find out unknown facts about those markets which could be useful to a prospective advertiser. The magazines had already analyzed their circulations along market area lines and the advertiser was getting for his money considerably more than mere space.

Progress in market research during the past fifteen years has led advertisers and their advertising agencies to the inevitable conclusion that the daily newspaper is the national market place. Other media have their place in the scheme of advertising for the building of prestige, for reminding the buyer that the goods and services he desires may be obtained, but for the sale of merchandise at a given point and a given price, no medium exists that can compete with the daily newspaper in

point of results delivered and of cost. The discovery of newspaper advertising by business in general is the great commercial achievement of the present age.

All advertising was expanding when the wet blanket of the European War smothered American industry for two years. Revival began in 1916, and in 1917 when the United States entered the war the new era was definitely under way.

The most striking object lesson for newspaper publishers and for business men generally was the use of advertising for Liberty Bond sales and war messages. Copy written without a thought of business selfishness or vanity reached new heights of beauty and appeal and its effects were magical. The war years speeded all industry to capacities that were unthinkable in 1914 and when the armistice came unexpectedly, the wheels could not be stopped without disaster. How to keep them running was the question and the answer was found in the tremendous surge of advertising that swamped all publications in 1919 and 1920.

The volume of advertising in magazines and newspapers was almost twice as large in 1919 as in 1914, and many publishers were smothered beneath the burden of prosperity. War-time increases in circulations were held, restrictions which had prevented waste of newsprint during war-time relaxed, and the tidal wave of advertising seemed to have no end. Publishers receiving the immensely increased volume of business were compelled to buy extra paper, new machinery, rent new offices, and engage additional employees to handle it. Every line of advertising in some newspapers was printed at a loss for months, because advertising contracts and rate schedules could not be adjusted quickly to the new conditions. The immediate result was suspension of many newspapers and consolidation of many others with their contemporaries, a war-time trend which has not yet reached its conclusion.

A secondary result was the rapid development of chain journalism—the ownership by one publisher or corporation of newspapers operated in different cities. Reference has already been made to the Hearst and Scripps-Howard groups, which are the largest in the country in point of circulation and num-

ber of newspapers operated. Many others have followed these pioneers and a survey by *Editor and Publisher* during 1927 showed 55 such organizations, owning 228 daily newspapers, with 89 Sunday issues, the papers having a total daily circulation of 13,190,710 copies and a Sunday circulation of 11,052,450 copies. This is 36.6 per cent. of the total daily circulation of all United States newspapers and 45.1 per cent. of the total Sunday circulation of American newspapers.

Another result was the assembling under one roof of two or more dailies in a single city, combining the overhead and production cost and making a profit on the united operation.

At the beginning of the era with which this brief sketch is concerned, there were about 867 newspapers of all kinds published in the United States. At the beginning of 1928, after all the consolidations of the war and post-war era have been noted, there are about 2,000 daily newspapers, of which 425 are morning, and almost 1,600 evening papers. Sunday papers number about 540.

Weekly newspapers now number more than 10,000.

Daily circulation is now in excess of 36,000,000 average net paid copies per issue and Sunday circulation is more than 25,000,000 copies. These are totals which testify eloquently the reason for the great commercial development of the press. Weekly circulation adds another 7,000,000 copies—a force which is gaining more and more importance to the advertiser seeking to reach every corner of the country with his message. Such programs are even now part of the annual budgets of many great corporations and appropriations for daily newspaper advertising of more than a million dollars a year are now commonplace.

Newspaper advertising rates have been increased, of course, during the years that have passed since the war. So have magazine rates. They are little higher in proportion to total circulation, however, than they were in 1914, and they are lower when the increased service rendered the advertiser by publishers of all classes is considered.

The *New York Daily News,* first of the modern tabloid newspapers, was established in 1919. The old-style papers

even then had attained a bulk that made it difficult to read them on a crowded street car or subway train, and the new journalism, fathered by Col. R. R. McCormick and Capt. J. M. Patterson of the *Chicago Tribune,* proposed to tell the news in as few words as possible, and with pictures wherever a camera or an artist's eye could be brought to bear on the subject. Within five years it had attained almost 1,000,000 circulation and its present statement shows more than 1,200,000 daily and about 1,500,000 copies Sunday—circulations never before attained in America.

In competition with the *Daily News* are the *Daily Mirror,* owned by W. R. Hearst, and the *Evening Graphic,* owned by Bernarr Macfadden, the successful proprietor of several magazines of the million circulation class. In other cities, tabloid journalism has had a spotty career. Three newspapers established by Cornelius Vanderbilt, Jr., in San Francisco, Los Angeles and Miami, failed after promising beginnings. Other tabloids published in Florida ceased publication when the real estate boom ended. Fair success has attended the two tabloids published in Philadelphia, the *News* by Macfadden, and the *Sun,* by Cyrus H. K. Curtis. In Baltimore and Washington, Scripps-Howard tabloids, called the *Post* and the *News* respectively, have progressed to a solid foundation after five years.

Unlikely as it may seem, it is none the less possible that the rise of the New York tabloids was helped by the activities of Mr. Frank A. Munsey in buying and consolidating older papers. Mr. Munsey had reëntered the New York field in 1912, buying the *Press,* a morning and Sunday paper. After operating it for four years, he bought the *Sun* and *Evening Sun* and in a few days combined the morning and Sunday editions. In 1920, the *Herald* of the Bennetts came into Mr. Munsey's possession with the *Evening Telegram* and the Paris edition upon which the younger Bennett had lavished his time and attention. The *Sun* and the *Herald* were merged in a few weeks, and the *Herald's* name returned to the morning paper field unaccompanied for a few more years, the *Sun* becoming a luminary of the evening sky. In 1924, Munsey sold the *Herald* to the *Tribune.* Neither morning paper was within sev-

eral hundred thousand dollars of meeting its expenses before the combination, but the *Herald-Tribune* manifested an almost instant attraction for readers and advertisers, and has been one of the most profitable newspaper operations of the country since 1924.

Mr. Munsey meanwhile had bought the *Globe* and combined it with the *Sun* and then merged the *Evening Mail* with the *Evening Telegram.* When he died two years ago, only the *Sun* and the *Telegram* remained in his possession of the many newspaper properties that he had owned and directed during his active newspaper career. The *Sun* was sold in 1926 to a group of its executives and employees headed by William T. Dewart, one of the executors of the Munsey Estate, and the *Telegram* passed to Scripps-Howard ownership early in 1927.

Mr. Munsey's activities left a considerable gap in the evening newspaper field and it is the opinion of many newspaper men that the all-day circulation of the tabloids filled this gap and prevented the full realization of Munsey's ambitious plans. Circulations have become more concentrated it is true. Advertising rates have been increased to the point where all but one of the old-line New York evening papers are on a profitable basis. Conditions in the morning field were not greatly altered by the *Herald-Tribune* consolidation beyond the construction of a strong property in the place of two financially weak papers.

What is true of the newspaper field has been demonstrated also in the magazine and trade journal publications. Number of advertisers and volume of lines used have greatly increased, but so have printing costs and payrolls. The publisher who could not increase his rate per line, or his volume at the existing rate was hopelessly mired in the path of costs that refused to be reduced. Publications which already had demonstrated their value to the field and were enjoying the reward of generous patronage had that reward increased. Publications out of step with their readers and advertisers lost what patronage they had and in innumerable cases consolidation has followed.

Expenses that would have appalled the editor of 1870, had he been compelled to apportion them over a year, are the normal weekly budget of many great publications in this day,

when barriers of time and space melt before him who has the energy and the money to apply the fruits of modern invention. The money is spent and the public rewards the wise spender.

With new means of communication opening before newspapers and other publications almost every day, their intelligent use is demanded. Pictures which five years ago could have been printed a week after the occurrence depicted are now front-page items the next morning and are useless to the publisher who did not use the telephone or the radio for their transmission across an ocean or a continent. A war between obscure bandit leaders in a Chinese province may be the first brand of an Asiatic conflagration and its strategy and tactics are breakfast-table news in every city in America. Daring aviators meet in Italy to see who can most nearly hold the sun even in his tracks and a corps of American correspondents put the epic on the cables. The public may not have demanded such extremes of service, but having tasted and felt them, the public will visit punishment on the newspaper which attempts, in the interest of economy, to curtail these efforts. Sure destruction awaits the newspaper whose executives meet their problems of 1928 with the mind of 1914, or even 1920. The publishing world has moved further in the past fifteen years than in the previous eighty-five and the pace is likely to quicken. If the chronicle of the printed word since 1828 holds entrancing chapters, the beginning of the new century holds forth hopes brighter than any that lit the horizon of Ben Day and James Gordon Bennett.

XII

RAILROADS

By L. F. Loree
President, Delaware & Hudson Co.

NEARLY a hundred years ago—in 1829—the perfection of the first practical locomotive, Stephenson's immortal "Rocket," paved the way to the century of railway achievement which comprises the romantic history of rail transportation. In that year the Delaware and Hudson Company took steps to introduce the first steam locomotive ever operated on this side of the Atlantic.

The first transportation undertaken by man was a personal effort in which he packed his own burden. This method still persists in an organized way in parts of South Africa, where trains of porters form the only transportation agency. Passenger transportation was carried on in much the same way, the papoose being strapped to the back of the squaw or a lady seated in a chair lashed to two poles and carried on the shoulders of bearers.

With the domestication of wild beasts, pack trains were organized. These animals were used also for the transportation of persons, various forms of saddles being devised for comfort and security. Even so late as 1750 almost the whole land-carriage of Scotland, and of several parts of England, was conveyed on the backs of pack-horses.

The condition of the main highways of England as described by travelers near the close of the eighteenth century was bad in the extreme. Transportation by wagon was not only intolerably slow but so expensive as to exclude every object except manufactured articles of light weight and small bulk in proportion to their value. Under the guidance of the

engineers Macadam and Telford, highways were built with careful attention to grades and their surfaces properly metaled. Many cartage companies were formed for transport and an allowance of one ton of goods for a horse was very general.

The introduction of railways as a substitute for common roads at Newcastle-on-Tyne took place some time prior to 1610. By 1750 there was scarcely an important mine but had its accompanying railway. The most of the railways descended in the direction the goods were to be conveyed, affording an easy draft to loaded carriages, and the descent was never so great but the empty carriages could be easily drawn up the acclivities. The only motive power for a long time after their introduction was horses, and as long as the wooden rail continued in use, the general load for one horse was 4,704 pounds. When the wood-way was plated with iron, a horse was enabled to haul 5,936 pounds, exclusive of the weight of the wagons.

The next improvement (about 1767) was the adoption of iron rails when the load of the horse was increased to nearly double the quantity theretofore taken upon the wooden rail.

This was followed by the introduction of the steam locomotive which definitely marks the transition from the old to the new relation. The efforts to give practicability to the philosophical idea of the use of steam power were pursued over a long series of years by many talented and skillful men, among whom are recognized as outstanding the names of Newcomen, Watt, Trevithick, Fulton and Stephenson.

The cylinder and piston, now so familiar, comprised from the first the favorite apparatus for experiment. Hugghens, in 1678, exploded gunpowder to raise the piston, allowing the atmospheric pressure above the piston to perform its work. The chief difficulty lay in obtaining a continual repetition of the force. Papin undertook to produce the vacuum by the use of steam. He was able to demonstrate a great principle, though he produced no useful machine.

Thomas Savery, a military engineer, designed a fire engine in 1698 which did not, however, fulfill expectations.

Thomas Newcomen, of Dartmouth, in 1705 invented the

atmospheric engine, the first engine having a piston moving in a cylinder. Having given several years to the perfection of the engine, he installed one near Dudley Castle, Wolverhampton, in 1712, for the raising of water from the mines. This engine is stated to have made twelve strokes a minute, and to have raised ten gallons per stroke from a depth of one hundred and fifty feet, with pumps of two lifts of seventy-five feet each. The mine operators quickly appreciated its advantage and a few years saw it in use for draining mines in all parts of the Kingdom. Its practicability appealed to America, one being brought to this country by Josiah Hornblower and by him set up and used in March, 1755, for pumping water from the Schuyler copper mine at North Arlington, New Jersey.

James Watt, of Glasgow, first improved Newcomen's engine in 1765 by condensing the steam in a vessel separate from the cylinder and saving the loss of alternately heating and cooling it. On January 5, 1769, the memorable patent for "a new method of lessening the consumption of steam and fuel in fire engines" was obtained. In May, 1775, the monopoly was extended for twenty-five years. The superiority of Watt's engine over Newcomen's in power and economy of fuel was soon demonstrated and the success of the engine was assured. So rapid was the adoption of the Watt engine that by the end of five or six years all the engines in England save one had been altered.

On March 12, 1782, Watt patented his double-acting steam engine, using the expansive force of steam below as well as above the piston, and at once solved the difficulty of applying it successfully to produce a continuous rotative motion. This was the crowning improvement. His patent of his sun and planet wheels, in 1781, was followed by his parallel motion in 1784 and later by his throttle-valve and governor crank, piston packing and indicator. Confined heretofore almost exclusively to raising water, the steam engine now entered upon a career of world-wide activity. Little new has been introduced in the mechanism of this engine; in its main features it is to-day very much as Watt made it.

Richard Trevithick, of Redruth, was the first to apply steam-power to the haulage of loads. His first steam carriage was tried out on a high road on Christmas Eve, 1801, with about seven or eight passengers. It ran half a mile the first day and a mile the next, both journeys being terminated by accidents. In 1803 a second engine ran about a mile. Subsequent trials in London were brought to a close by an accident to the engine, and ended Trevithick's attempts to introduce steam carriages on common roads. In 1804 he renewed his efforts on a railed road with a non-condensing engine which hauled, in five wagons, ten tons of iron and twenty men a distance of nine miles in four hours and five minutes. The weight of the engine broke many of the tram-plates, which were of cast iron. Its failure was due to the weakness and roughness of the tram-road rather than to the defects of the engine itself.

In 1804 Oliver Evans, an American inventor, applied one of his five-horsepower engines in the transportation of a large flat-bottomed craft in Philadelphia. This steam dredging-machine, weighing about four thousand pounds, was propelled by its engine from the works to the Schuylkill. The engine was then applied to the paddle-wheel at the stern, and drove the craft down the river to its confluence with the Delaware. His later efforts were confined wholly to marine and stationary engine construction.

Blenkinsop's rack-rail locomotive began running in 1812, the first instance of the regular employment of locomotive engines, and continued in use many years. Chapman's chain engine, first used in 1813, was found liable to get out of order on account of the chain giving rise to great friction, and was soon abandoned. Hedley's smooth-wheeled engine, introduced in the same year, at first went badly, the obvious defect being lack of steam. His second engine, in which the fire-tube was returned through the boiler, regularly drew eight loaded coal wagons at the rate of four or five miles per hour, and satisfactorily demonstrated that no further aid was necessary than that supplied by the adhesion of the wheels to the rails.

For a considerable number of years few improvements of much note were effected in the locomotive and, even as late as

1827, its fate still hung in the balance. On many railways the use of the locomotive had been abandoned in favor of rope haulage, and while it was continued in use on the Stockton and Darlington line, the principal haulage of that line was performed by horses. As yet locomotion by steam had not achieved much success; an efficient form of engine remained to be invented.

At this juncture, Timothy Hackworth, a native of Wylam, designed an engine in which he introduced important modifications, whereby the power and compactness of the smooth-wheeled locomotive were much advanced. Departing from the usual plan of two upright cylinders, working on different shafts, Hackworth inverted his cylinders, and placing them on opposite sides of the boiler, applied their connecting-rods to actuate the same axle-tree. At the same time he adopted the return fire-tube which had been used by Trevithick and Hedley, and by throwing the escaping steam into the chimney through a narrow orifice, he greatly augmented the force of the steam blast and consequently the rapidity of combustion in the furnace. This engine, which was a six-wheeled coupled engine, was the first of a new type and the nearest approach to the modern locomotive of any that had yet been built.

George Stephenson, to whom is generally accorded the honor of having first made the locomotive engine a success, built his first engine at Killingworth in 1814. Following the design of Blenkinsop's engine, he employed a cylindrical boiler of wrought iron with an internal wrought iron fire-tube passing through it; also two vertical cylinders of eight inches diameter and two feet stroke, set in the boiler, with crossheads and connecting-rods to work the propelling gear but using the smooth wheels. It drew, exclusive of its own weight, eight loaded wagons, weighing altogether thirty tons, at the rate of four miles an hour.

In 1824 Stephenson commenced the business of locomotive-engine construction at Newcastle-on-Tyne. His first order was for three locomotives for the Stockton and Darlington Railway. The first, or "No. 1," engine was delivered in time for the opening of the road on September 27, 1825. Its boiler

contained a single straight flue, one end of which was the furnace. The cylinders were vertical, and coupled directly to the driving-wheels. The two pairs of drivers were coupled. The engine weighed eight tons.

When the work of building the Liverpool and Manchester Railway approached completion the directors were unable to agree upon the method of operation. Some favored the use of horses; many preferred rope-haulage, and the remainder were undecided. The locomotive had no outspoken advocate, and few had the slightest faith in it. The consulting engineers recommended rope-haulage, which Stephenson so persistently opposed that the Board, after much consideration, decided to offer a reward of five hundred pounds for the best locomotive to operate under the conditions prescribed.

Of the four locomotives competing, Stephenson's "Rocket," tried on October 8, 1829, at Rainhill, alone met all requirements. This locomotive, which inaugurated the era of fast transportation and made possible an industry that has revolutionized society and commerce, remained in service on the Liverpool and Manchester Railway until 1837, when it was sold to the Midgeholme Railway, and is now in the Science Museum at South Kensington, London, England.

In the United States public attention had already been directed to locomotive steam engines by Oliver Evans and Colonel John Stevens, the latter predicting, with confidence, as early as 1812, that it would become possible for a steam carriage to move upon rails with a velocity of one hundred miles per hour.

Colonel Stevens, in 1825, had built a small locomotive, which he placed on a circular railway at his home in Hoboken, New Jersey, to prove that his statements had a basis of fact. This exhibition even though unsuccessful created such widespread interest that it materially aided in securing a rapid adoption of the railroad when once introduced.

During the construction of the Delaware and Hudson Canal Company's canal projected from the Hudson River to the coal beds at Carbondale, which was chartered April 23, 1823, the company's engineers, finding that the crossing of the

Moosic Mountain, between Honesdale and Carbondale, was not feasible, recommended to the managers that a railroad be built between these points as the final link in the transportation route from the coal mines to tide water.

Four years later, John B. Jervis, the chief engineer, began the survey and construction of this railroad, sixteen miles long, consisting of inclined planes on which cars were moved by rope-haulage with the use of winding drums, actuated by stationary steam engines, and "levels," or moderate gradients, between the planes on which the use of locomotives was planned.

In February, 1828, the management sent Horatio Allen, one of its engineers, to England, with authority to purchase iron rails and four locomotives for use on this railroad. One of these, the "America," was built by Stephenson and Company. The other three, the "Stourbridge Lion," the "Delaware," and the "Hudson," were built by Foster, Rastrick and Company at Stourbridge. The "Stourbridge Lion," arriving in New York on the ship "John Jay" on May 13, 1829, was set up and demonstrated on May 28 at Kemble's works of the West Point Foundry Company on Beach Street. It reached Rondout on July 3, 1829, and cleared Eddyville, on the canal, on July 16. It was placed on the track at Honesdale on August 5, and made its famous trial trip between Honesdale and Seeleyville, driven by Horatio Allen, on August 8. Although discarded after a second trial on September 9 because its weight of eight tons in working order was too great for the track structure, it was the progenitor of the massive and powerful locomotives now employed on our American railway systems. Its boiler and some of the other parts are now in the Smithsonian Institution at Washington.

The "Stourbridge Lion" was a four-wheeled coupled engine. The firebox was cylindrical and forty-eight inches long by twenty-eight inches wide. The boiler was cylindrical, fifty inches in diameter and nine feet six inches long, and had two tubes eighteen inches in diameter and four feet long. The two cylinders, eight and three-quarters by thirty-six inches, were vertical and coupled with a grasshopper type motion to the rear

pair of drivers. The boiler was set on a frame supported by the drivers which were forty-nine inches in diameter.

The purchase of these locomotives was a conspicuous example of foresight and courage, for although there had been some use of locomotives in transport in England since 1811 and a number were in use on the Stockton and Darlington, there was sharp denial of their claims of superiority to the horse and their supremacy was not decisively demonstrated until the Rainhill trials on October 8, 1829, nearly two years after the order was placed.

The first American locomotive built for actual service was the "Best Friend," built by the West Point Foundry Company from designs by Peter Cooper and put in service on the Charleston and Hamburg Railroad, South Carolina, in January, 1831. On June 17 following, the boiler exploded, because of the negro fireman sitting on the safety valve. In 1831 Horatio Allen designed for this road the first eight-wheel engine. In August, 1832, John B. Jervis put in service on the Mohawk and Hudson Railroad the first locomotive, the "Brother Jonathan," with a bogie or swivel truck under the front end of the locomotive to assist in sustaining the weight of the boiler and in giving direction to the locomotive in running around curves, a plan later adopted as indispensably necessary in engines of eight or more wheels, and especially upon the sharp curves of American railroads. Few devices have had more far-reaching results on the social life of our people than the bogie truck in our locomotives, passenger and freight cars.

The success of the Jervis bogie truck gave birth to a new American industry, that of locomotive building. Called into existence by the early requirements of the railroads of the country, this industry has grown with their growth and kept pace with their progress. From the beginning of the industry by Matthias W. Baldwin in 1832, the progress of locomotive engineering in increases in capacity, efficiency, weight and refinement of details has been rapid, and is too widely known for repetition.

Two comparatively recent outstanding locomotive improve-

ments—the booster and high steam pressure—are, however, worthy of mention. The booster, introduced in 1919-20, is a small auxiliary engine attached to the tender or to the locomotive trailer truck. This device enables great concentration of power in starting the train and in moving it over comparatively short stretches of heavy grade. The increase in steam pressure has not kept pace with other locomotive improvements. The Baldwin locomotives of 1834 carried about one hundred pounds pressure. By 1923, with the familiar self-contained type of multitubular boiler in combination with the superheater, the pressure in general locomotive practice was two hundred pounds.

In 1924 the Delaware and Hudson Company, keeping up the tradition derived from the achievement of introducing the first steam locomotive ever operated in the Western Hemisphere, introduced a new and more efficient type of freight locomotive in which the steam pressure was increased to three hundred and fifty pounds.

This design, the result of more than forty-five years of personal research and study with the aid, in later years, of others among the officers and employees, following modern stationary and marine engine practice, does away with the water legs and the water over the crown sheet and substitutes therefor self-supporting cylindrical containers. The firebox itself thus contains almost 1,200 square feet of heating surface as compared with from 300 to 450 square feet in the largest combined fireboxes and combustion chambers of the conventional locomotive boilers, so that in the production of steam 75 per cent. instead of 40 per cent. is generated by radiation at the firebox end of the boiler, where it can be most effectively and economically generated. This locomotive weighs 298,500 pounds on the driving wheels and develops 75,000 pounds of tractive force. Working single, with a booster cut in at 105 pounds pressure, the tractive force is increased to 105,000 pounds, the greatest draw-bar pull of any four coupled locomotive of which there is record. Under like operating conditions this locomotive moves 1,000 actual gross-ton miles with a consumption of

55 pounds of coal compared with 130 pounds consumed by the best modern type of consolidation locomotive.

Early in the present year a second locomotive of essentially the same design was brought out in which the boiler pressure was increased to four hundred pounds and the firebox increased fifteen inches in length and three inches in width. Through the elimination of some auxiliary devices and refinements in design the weight of the locomotive has been considerably reduced. The exterior, in strange contrast with the ancient and modern practice, resembles a monster boiler on wheels with all appendages except the bell concealed beneath the jacket. These locomotives are daily performing satisfactory service and are economical in operation. They have ushered in a new era in locomotive engineering and, in addition, demonstrated that steam power is not yet to be thrown, as some enthusiasts would have it, in the economic discard.

The steam railroad to-day exerts a capacity per man employed in its freight transportation 2,105 times greater than the capacity of the African porter.

In 1884, electricity was applied in the movement of street cars in Cleveland, Ohio, and came rapidly into use. This system, in essence a rope-haulage system, was so superior that it drove the individual unit system—the horse-drawn car—out of service and completely supplanted it in city and interurban transit.

About 1898, with the application of the internal combustion engine to road vehicles, there began development of the automobile. In its turn this individual transportation unit, whether used as a pleasure car, as a motor bus, or as a motor truck, has rapidly driven trolley lines of meager traffic out of service.

There is the further possibility that a cheap, durable and fool-proof electric storage battery may yet be invented, enabling the use of its power by an independent unit in transportation, completing the discomfiture of the rope-haulage trolley car.

While the contest may be expected to continue long in the future, perhaps usurping and stabilizing itself in restricted fields, the dominance in the larger aspect will depend largely

upon the ability, genius, courage and tenacity of the exponents of one or the other methods of transportation. For myself, I have an abiding faith that for the main purposes of the railroad—the transportation over long distances of heavy articles—the unit system of transportation will be the dominant one.

The vehicles in which freight and passengers are carried have undergone an analogous development. Freight was at first moved in the chaldron, with a carrying capacity of something over two and one-half tons; by 1860 there was developed a five-ton car, with four wheels, the axles fixed in the frame. The Civil War compelled an increase in the carrying capacity and the car advanced to ten tons and eight wheels; with the wonderful increase in railroad mileage in the early 1870's the capacity was increased in 1873 to fifteen tons; in 1876 the twenty-ton car was introduced; in 1883 the twenty-five-ton; in 1885 the thirty-ton; in 1895 the forty-ton; in 1900 the fifty-ton; and in 1915 the seventy-ton, of which there were in use at the close of 1925 more than 121,000. The refrigerator car was introduced in 1871; the stock car with watering troughs and feed bins about 1881, and in 1894 the modern steel freight car became a recognized unit of American railway service.

The first car used for transporting passengers in 1825 on an English railway resembled a small cabin on wheels. In this country, in the beginning, practically ordinary stage coaches fitted with flanged wheels were used. In 1832 the eight-wheel car appeared. In 1838 the first sleeping car, a crude affair, was put in service. In 1869 the Pullman sleeping car was introduced, originating a system of day and night travel in comfort, safety and convenience; the dining car in 1868, and the parlor car in 1875. The all-steel passenger car came into use about 1908.

In passenger service the hand brake, originally used, began to be supplanted by the air brake in 1869. By 1875 the passenger trains of nearly all the principal roads were fully equipped with the air brake. The primitive link and pin method of connecting passenger cars commenced to give way to the coupler and buffer in 1863. Light was first furnished

about 1840, two candles, one in each end of the car, being used. Oil lamps were introduced about 1867. These were supplanted by gas in the early 1880's, which in turn has largely given way to electric light. The enclosed vestibule, permitting convenient passage through trains, was introduced in 1886, and the old method of heating the cars by stoves gave way to steam drawn from the locomotive boiler at about the same time.

The invention and improvement of the locomotive was preceded by, and was largely consequent upon, the construction and improvement of the track upon which it operates. The first railways in England were wooden "way-leaves," which came into use between 1602 and 1649. They were constructed of wooden rails laid on cross sleepers, and came in time to be generally known as "tram" roads. About 1738 thin plates of iron began to be nailed on, to protect those parts most exposed to wear. In 1767, iron bars five feet long, four inches wide and one and one-half inches thick were substituted for the wooden beams. These rails were laid flat, the upper surface being slightly trough-shaped. About 1776 rails with an upright flange or guide on the outside, to prevent the wheels from slipping off, came into use. The edge rail, invented by Jessop in 1789, followed. This rail Jessop almost immediately strengthened, changing its form to that known as the fish-bellied. This change, introducing the pear-shaped head, required the use of a flange on the wheel, which practice persists to this day. The fish-bellied rail was improved by the half-lap-joint rail, patented by Stephenson and Losh in 1816, and these in turn were superseded by the wrought iron T rail, fifteen feet long and weighing twenty-eight pounds to the yard, introduced by Birkenshaw in 1820.

The flat-based, or flange, rail was designed by Robert L. Stevens, President of the Camden and Amboy Railroad, now one of the Pennsylvania Lines, and was first rolled in 1830, in Wales, five hundred rails, eighteen feet long and weighing thirty-six pounds to the yard, being shipped to Philadelphia in 1831. This type of rail has now come into universal use in this country and in Europe.

In 1834 the bridge rail was designed by the American,

Strickland, and introduced into England by Brunel the following year. It was a rail of this form that was first rolled in this country; it weighed forty-two pounds to the yard, and was rolled at the Mount Savage mills, Allegany County, Maryland, in 1844. It has long since passed out of use.

Henry Bessemer had already discovered the pneumatic process of steel making, and as early as 1857 the first steel rails were rolled. Their importance as giving greater endurance and resistance to breaking was at once recognized, but they came very slowly into general use because of their high comparative cost. The development of heavier equipment necessitated a corresponding increase in the weight of steel rail, which, by 1869, had increased to sixty pounds to the yard, and by 1889 to eighty-five pounds. In 1892 the "Hercules" rail, weighing 127 pounds to the yard, was put into service. Since then the weight has only slightly increased, the present general standard for lines of heaviest traffic being 130 pounds to the yard.

The rail is greatly modified in two subordinate forms of construction: first, the switch, for diverting the wheels from one line of rails to another; and second, the frog, enabling the wheels to pass a line of rails.

The early switches were the simple tongue, still to be seen in street railway tracks. After a time the points were rigidly connected so that they might move together. This point or split switch, with some modifications in form, is still the type in most general use. The stub switch, invented by George Stephenson, for many years was the usual type in this country. The Wharton switch, lifting the wheel over the rail so that the main track line remains unbroken, is much in favor for detached and little-used sidings. There have been many variations, but, for the most part, they have failed to stand the test of continued use.

The early frogs were of cast-iron in solid blocks, and later, plates of wrought iron riveted to the cast base. At present these appliances are constructed of rail, properly placed and secured by rivets, bolts or clamps. The spring frog is in general use for main tracks, wearing about three times as

long as the stiff frog, and giving a much smoother riding surface. The confined space into which tracks have often to be crowded and the growing use of interlocking machinery have led to the invention of diamond crossings, single and double slip crossings, rocking or movable point frogs and other ingenious variations of this appliance.

In the days of stone sleepers, the rails were sometimes fastened by spiking directly to the stone blocks, but were more generally placed in shallow chairs and secured with an iron or wooden key. Where wooden sleepers were used, the chairs were fastened to them by two button-headed spikes. We owe the hook-headed or dog-headed spike to the genius of Stevens, who, to avoid the delay caused by the failure to receive the stone sleepers for the Camden and Amboy Railroad from the quarries, had his flange rail spiked to cross ties as a temporary expedient, inventing for the fastenings the spike now universally used. Many modifications in its form have since been invented and continue to be reinvented.

The joint has also been materially improved. The strap rail imported by the Delaware and Hudson Company, in 1828, for its railroad between Carbondale and Honesdale, Pa., was of the tongue and groove joint pattern. One end of the rail was fitted with a tongue five-eighths of an inch wide and three-fourths of an inch long which fitted into an equivalent recess in the adjoining end of the next rail. Stevens connected his flange rails on the Camden and Amboy with a short, straight bar of iron secured to each rail, the rivet giving way about 1832 to the bolt and nut. This track was, at that time, a complete example of what has deservedly come to be called the American type of construction. The importation of Stephenson's English chairs drowned out for many years the idea of Stevens. In 1847 W. B. Adams reinvented the fish-plate joint, which, developed into the angle bar, has come to be the generally used form. Meantime a countless legion of these devices have been invented, but for the most part their history is like that which the prophet depicts of man:

> "He cometh forth like a flower and fadeth,
> He fleeth as a shadow and abideth not."

Stone blocks were first used as sleepers. They were carefully dressed and laid diagonally, and after being given an extensive trial were gradually abandoned.

The wooden cross-ties which superseded them were in some instances mortised down upon, and treenailed to, longitudinal stringers. This construction was soon abandoned and the present familiar type laid in ballast became fixed.

Longitudinal wooden stringers originated in America and were used for many years on some railways, but found their principal service in England, where their use was discontinued upon the abandonment of the broad gauge.

The cross-tie has been much imitated in iron shapes. About 1862 ties of rolled or wrought iron came into use in Holland and this type, with a change of material to soft steel, has since come to be a popular form in use in Central Europe. The steel tie has the great merits of durability and of permitting the rail to be so securely fastened as to eliminate the danger of spreading the gauge, but its excessive cost has prevented adoption generally. Exhaustive experiments are now being made with ties of concrete and of scrap rails, the former on the Pennsylvania Lines and the latter, consisting of two pieces of worn out rail welded together, in the tracks of the Delaware and Hudson Company.

The gauge of the railways of the United States with the exception of the narrow-gauge, mine and industrial plant roads has been standardized. Our early roads were of various gauges ranging from four feet three inches to seven feet. Later some lines of lesser widths were built in mountainous regions. By 1890 all had been discontinued except the four feet eight and one-half inch gauge, which had been previously adopted as standard, and the narrow-gauge (three feet) lines, some of which have since been widened. This standardization has brought practically the whole railroad system of the country into direct communication and has made possible the comforts of through travel and the economical interchange of traffic.

The progress of the American railways has no parallel in any other time or clime. By successive steps these railways through inventive genius, economic incentive, individual initia-

tive and freedom of contract have expanded within the century from a capitalization of $1,500,000 in 1825 and a total length of twenty-three miles in 1830 into a great transportation system of 249,398 miles with a total outstanding capitalization at the close of 1925, the latest figures available, of $23,644,-224,072 of which the public holds $18,190,513,329.

When railroad construction began the country west of the Ohio was practically an unsettled wilderness. Its development was preceded by railroad construction. The necessity of transportation was so widely appreciated that not only was every enterprise welcomed with great cordiality but Federal, state and local governments themselves assisted in every way possible. A long experience has developed many avenues of government aid; protective tariffs, subsidies, bounties, freedom from taxation, land grants, etc. Many of these were put at the service of the railroads; most conspicuously the grants of unsettled land. But the demagogue has ever been an "Indian giver"; one day he thrusts his largess upon you with both hands and the next he seeks to tear it away with teeth and claws. What seemed to be at the time a gracious boon has been later made to appear a matter of reproach.

The work of consolidating connecting lines began in the early 1850's. Two of the most important instances were the consolidation, in 1853, of the numerous companies which built the railways forming the main line of the New York Central and by the purchases and leases which secured to the Pennsylvania control of a continuous line between New York and Chicago in the early 1870's. Consolidations became so numerous after the close of the Civil War that for many years they formed a leading feature of railway development. Through these combinations the public interests were greatly promoted, especially by the improvement of facilities for cheap, rapid and convenient movement of passengers and freight between distant points, the avoidance of delays and changes of cars, the reduction of freight charges, and the increased responsibility of the carriers.

The great systems radiating from Chicago and St. Louis were developed during the period from 1865 to 1890 with a rapidity rarely equaled. Connections were soon established

with the eastern lines which promoted the transportation of passengers and freight between the Atlantic and the Pacific and between the Great Lakes and Gulf ports.

This process of consolidation was brought to a halt in 1905 by the Supreme Court's decision in the "Northern Securities Case," forbidding common control of the Great Northern, Northern Pacific and Burlington railroads. The possibility of extensive consolidations has been renewed by the Transportation Act of 1920, which seems to contemplate the consolidation of 174 Class I, 282 Class II and 348 Class III railroads of the United States into a relatively small number of systems. The tentative recommendations of the Interstate Commerce Commission contemplate only nineteen.

It is difficult adequately to picture the progress of the railroads in their rôle as arteries of commerce within brief limits by statistics of train-miles, car-miles, passenger-miles, ton-miles, etc. An indication of the enormous progress of the railways can, however, be given by a brief summary of the percentage rates of increase, during the three decades ended with the year 1926, of some of the most important items connected with their operation, as follows:

Item	*Rate of Increase*
Miles of line operated	37.1
Miles of all track operated	72.4
Operating revenues	465.7
Operating expenses	505.7
Operating net revenues	362.1
Net capitalization	125.3
Weight of locomotives	403.3
Cost of fuel	154.0
Capacity of freight cars	253.0
Average tons per freight train mile	261.8
Ton miles per mile of road (traffic density)	224.4
Employees (number)	121.8
Compensation of employees	545.8
Taxes	896.5

Transportation has become a science, and scientific knowledge of many matters affecting it, and the skillful application of scientific principles to each of many things, are vitally

necessary to attain the best results. This great truth has too often been ignored, and to a disregard of it many disasters may be attributed. All progressive nations desire to secure the advantages derived from superior systems of transportation. These advantages can best be secured by keeping the railways on a commercial footing. The assumption of governmental control of the railways during the World War was a costly experiment, but the resulting loss to the taxpayers was a small price to pay for the final abandonment of the economic heresy of government ownership, which is now discredited and, let us hope, dead. The difference between the condition of the country had governmental control continued, and that now existing, may be more readily imagined than described. The wisest thing governments have ever done in connection with this subject was to authorize private capital to make and operate the steel arteries of internal commerce; and the wisest thing they can do in the future is strenuously to avoid intermeddling with an honest discharge of the duties of the corporate managers to railway investors, travelers and transporters.

The development of the railways brought about legislative efforts to regulate their operations. In 1869 Mr. Charles Francis Adams secured the creation of the Massachusetts Railroad Commission. Its underlying theory was that any abuses in railroad operation could be controlled by authoritative investigation and publicity. This was a council of perfection.

In following years railroad commissions were organized in nearly all of the states and in 1887 by the Federal Government. Organized as regulatory bodies, these bureaucracies have steadily interpreted regulation to mean management and pursued the policy of absorption of managerial functions. This perhaps makes itself apparent more in the structure of rates and fares than any other of the railroad activities.

When the railroads were built their tariffs were constructed upon the basis of the value of the service rendered, as was and is the universal practice for private services of the physician and lawyer, and of general services rendered by manufacturers and by purveyors. The commissions have sought, and to a considerable degree are substituting, a tariff built on the basis

of the cost of the service, and for convenience have identified this with a distance tariff. This not only defeats the very purpose of transportation, which is to fight geography, but the effect, not yet generally recognized, seems to be a redistribution of population and industrial activity. In the earlier days manufacturing was located generally adjacent to the field of production of the raw material, the finished product being shipped to the market. Under the distance tariff manufacturing is located adjacent to the market to which distribution is made, the raw material being assembled from more distant points. Whether or not, when the full consequence of this change becomes apparent to communities, it will be allowed to continue and what the ultimate effect will be when the practice is carried to its logical conclusion, is one of the outstanding problems of the future.

The railroads have been one of the most potent aids in the development of the extractive and producing industries, placing facilities at their command for supplying old and finding new markets, and sustaining them in meeting the encroachments both from abroad and from competing regions. The disturbing element in the situation has been the marginal trader, who, lacking the ability to stand upon his own feet, fastened himself upon the railroads for support, and much of the clamorous criticism and adverse legislation has come from that source. One of the significant things in the history of the railroads has been the extent to which they have been the "Grand Almoners" of industrial life.

Quite as characteristic has been the development of the working force of the railways. In this service the men, besides necessarily strict physical requirements, are held to a high state of discipline. In the main, they are subject to be called upon for duty at all hours of the day and upon all days of the year. They are under control, not only as to the disposition of their time, but as to some of their personal habits.

The employees of the railroads are engaged in a hazardous occupation. Dread of injury resulting in temporary or permanent disability and of poverty in old age has always confronted them. In their increasing efforts to improve the

human relationships many of the managements, as early as 1886, worked out and put into effect pension systems. This was followed by the installation of group insurance affording employees and their families protection against the other major hazards of life—accident, sickness, unemployment and the calamity of death. This in turn has been followed by continuity of employment or the elastic day which has eliminated the old practice of employing men on the basis of full working time and when work slacked off to discharge the supernumerary forces. Under this system employment is based upon a working day of eight hours and upon the minimum force needed during slack time. As business improves the working day may be lengthened to nine or ten hours. Thus when work increases the men have the opportunity of earning substantially more wages. Comfortable working conditions are a responsibility of the management. Good wages are a joint responsibility of the management and the men. Wages are, in the long run, determined by output, and if we can keep up a good production standard we ought to be able to keep up a good wage standard.

The working organization of the railroads, like those of the world, is, in some respects, quite simple. It consists of three elements: *Why, How* and *When.* But simple as it is, it is only when these three elements hang together, like the three links in the Odd Fellows' emblem, that we have a dependable chain. *"Why"* is the business of management. In seeking answers as to *"Why,"* we go to the people who are specialists. Why is it that we seek to raise the steam pressure on our locomotives? The people who tell us "why" explain that the great expense in creating steam is in changing the liquid water into the vapor steam. Once turned into steam the temperature can be raised with very little heat. Many of these answers to *"Why"* are given by the people within the railway organizations, the technicians in the offices of the Superintendent of Motive Power, Chief Engineer and others. For many other answers we have to go to outside specialists.

The *"How"* involves the joint efforts of the three associates. A plan must be conceived by management, the field to

be covered and the means essential to its execution investigated. The business must be organized, energized and directed. There must be a relation of all the parts to work in harmony to a common end. Capital, the product of labor and intelligence, which, instead of being dissipated currently, is, through abstinence, self-denial and foresight, saved and put to the service of others, must be secured for the provision of plant, equipment and tools, and the power to drive them. In the specific performance of labor there is reflected the range of intelligence, character, and skill, which differentiates one man from another. No one can learn the *"How"* in this regard as he who does the work with his own hands. Only so can a high degree of skill be acquired.

The *"When"* is a problem of management. Shall we buy material now or wait? Shall we undertake this improvement now or shall we have to wait until our reserves are more substantial? Shall we effect this change in the method of doing business or is the chance of success too problematical?

While these elements are totally different neither of them gets one anywhere unless the other two go along, in the conduct of a business as complex as is the railroad business, one in continuous and uninterrupted operation; and intimate as all our relations must be, we should all of us do our best to live together in forbearance and mutual helpfulness; that our posterity will find their conditions so improved as to make them feel that our accomplishments were even greater than those of our forbears.

The railroad rests its hope of successful operation very largely upon organization, discipline, and continuity of employment. It must have a continuous policy, a history personal in its character, and an *esprit de corps* founded on mutual experience, respect and confidence. Here, as in other fields, the whole is not merely the sum of all the parts, but that sum plus the interaction of the parts, regulating, inhibiting, stimulating, multiplying their effectiveness and force.

The railroads are the instrument that has enabled national extension beyond the boundaries of early days and welded an immense area into a compact political and economic entity,

united in patriotic spirit, in industrial and commercial interest, in sympathetic understanding. In their comprehensiveness they may indeed be considered as works of nature wrought by man.

The wealth of the country, more evenly divided here than in any other part of the world, was not sufficient before the war for a higher standard of living than then obtained. The one hopeful way for the future is through increase in production.

If the rewards of the future are to be increased, the most important task, incumbent upon employers and employees alike, is to increase the national production. If we fail, the first signs of failure may be looked for in the system of transport, the breakdown of which has involved in destruction those nations which have perished in the past, and is the explanation of their passing. Happily our system of steam railroad transportation gives no sign of internal weakness. Quite the contrary, perhaps never has it been in a position to face, with greater courage or determination, the duties of the future.

Few activities play a more important part in military operations than transportation. In no small measure the Federal government owes the successful termination of the Civil War to the advantages it enjoyed in its steam railroads.

Including the Kentucky Blue Grass Region with the North, and Western Kentucky with the South, the Southern System comprised about nine thousand miles and employed about seven thousand five hundred railroad men; the Northern System comprised about twenty-two thousand miles and employed about twenty-nine thousand men. The Northern System was the more complete. Two-thirds having been completed in the preceding decade, it was newly equipped and in good physical condition, well situated to maintain the industrial life of the nation in the changed conditions as well as to perform the military obligations thrown upon it by the war. The management and personnel were at an ideal point to meet an unexpected situation. Moreover, the railroad business was the only "Big Business" in the country. No other institutions drew their capital from as widely extended territory, did business of as far-flung scope, or handled man labor of such number and variety.

Before the Civil War the use of railroads for military purposes had been comparatively unimportant and this experience marked one of the distinct departures of the new from the old military practice. The railroads became incorporated into the mechanism of civilized war.

The Government never undertook to requisition in the North all means of transport. In fact it was neither desirable nor necessary. The roads showed a ready spirit of helpfulness. On the whole the railroads were willing, the Government generous, and the emergency was better met by the regular railroad officials than it would have been by direct Government control.

In the World War, into which the United States entered on April 6, 1917, the experience was quite different. The inelasticity of railway rates under Federal regulation as practiced made it impossible to protect the man-power of the railways from the competition of unregulated industries that were stimulated by new demands of warfare. The steam transportation was thrown into much confusion by the issuance of priority orders. At one time each car of 85 per cent. of those under movement on the Pennsylvania Railroad was under a priority order, to be moved in preference to every other car. Finally, the roads of the entire United States were taken under Federal control on December 28, 1917. If the administrative wisdom of the act could at all have been justified, it should have been limited to the territory east of the Mississippi and north of the Ohio and Potomac Rivers. The treatment of the roads by the Government was in marked contrast to the period of the Civil War, and although the President had formally undertaken to see that they were returned as fully equipped and in as good condition as when taken over, they were allowed seriously to deteriorate in their physical condition.

The total cost assumed by the Government during the twenty-six months of Federal control and the six months of the guaranty period was reported by the Director General as $1,674,500,000. The railroads claimed, but their claim was disallowed, that the Government should reimburse them for failure in maintenance by $840,428,372.49. They suffered also from changed conditions, increases in rates of pay, working

conditions, etc., in a way that set up much embarrassment and which can only be corrected over a considerable period of years.

Should a state of war be again thrust upon us the preservation of the power and majesty of the nation will depend in a large measure upon the utilization of the facilities and resources of the railroads. The line of military weakness of the United States runs from Chesapeake Bay to Lake Erie. An enemy entrenched upon it would so divide the resources of the country that its ability successfully to prosecute a defensive campaign would be doubtful. This should be kept constantly in mind by public authorities and every encouragement given to the development of steam railroad facilities that would protect this region.

A secondary line of weakness is the Pacific coast. The range of the Sierra Nevada mountains lies so close to the ocean that an enemy making a successful lodgment could push through to its base and entirely cut off north and south communication. It is of importance that a continuous line of steam railroad be opened up from the Canadian to the Mexican border east of the Sierra Nevada range. Much of this is already in existence, but the gaps would require the construction of approximately one hundred and fifty miles. If these are not justified commercially the Government might well consider, as a military measure, promoting this construction by subsidies.

XIII

BANKING IN THE UNITED STATES

By Charles E. Mitchell
President, National City Bank

BANKING as it is known to-day was not very old in the world when Alexander Hamilton planned the first Bank of the United States, modeling it largely after the Bank of England. There had been money-lenders and exchange-dealers since as far back as history runs, but the Bank of England, which was the first banking institution of the modern type, was scarcely 100 years old.

Institutional banking had little or no development in the American Colonies. There were no incorporated banks in the country at the beginning of the war for independence. Trading was largely local, much of it of the nature of barter. Merchants performed the simple banking services for their customers, and of course there were private money-lenders. Money was scarce. In 1781 Hamilton estimated the total amount of specie in the country at about $6,000,000. The coins were from the mother country or of foreign origin, mainly silver from the Spanish colonies. At that time and until about the middle of the following century the principal function of a bank was thought to be that of issuing its notes for circulation. The common use of checks developed much later, and it was not until 1855 that the aggregate deposits of the banks of the United States exceeded in amount their outstanding notes.

The Colonies had emitted bills of credit in the form of currency, and as this was usually done without provision for prompt conversion into coin they suffered varying degrees of depreciation, even though they were a legal tender. Experi-

ence with such bills prompted the framers of the Constitution of the United States to place in it a provision forbidding the States to issue them or to make anything but gold and silver a legal tender for debt.

The Confederation which fought the war of the Revolution was a loose organization which had little power to levy taxes. It resorted to issues of paper currency in the form of promises to pay Spanish silver dollars, and this currency was made a legal tender not only by the Confederation but by the several States. It gradually depreciated as the issues increased, until by 1781 it had become worthless and ceased to circulate.

The first permanent banking institution in the United States was planned by Robert Morris, the Superintendent of Finance for the Congress of the Confederation, in collaboration with Alexander Hamilton, in 1781. Cornwallis had surrendered and Independence was near. The institution, called the Bank of North America, started with a capital of $400,000, and received a charter from the Congress of the Confederation, but there being some question about the authority of the Congress to grant a charter the bank soon after opening obtained one from the State of Pennsylvania. This was subsequently revoked in a spasm of hostility to a "monopolistic institution" of that kind, but later another was obtained and renewed at times until in 1864 the Bank of North America of Philadelphia entered the National banking system, to which it still belongs.

The Federal Government under the Constitution succeeded to the Confederation in 1789, with George Washington as President and Alexander Hamilton as Secretary of the Treasury. The latter had long been a strenuous advocate of a National Bank, as an aid to the operations of the Treasury and to provide a trustworthy currency.

Two banks had been established in the country since the Bank of North America began business, viz.: the Bank of Massachusetts, organized in 1784 with a capital of $1,600,000, and the Bank of New York, organized as a common law association in 1784, with a capital of $950,000, although it did not obtain a charter from the State until 1791, owing to popular

hostility toward a corporation for issuing money. That the public had little knowledge of banks is evident from the fact that Hamilton's argument for a National bank was largely devoted to an exposition of the general benefits of banking service, although he stressed the special services which it would be able to render to the Treasury. He advocated the bank as a safe means of providing a currency redeemable in specie, and took strong ground against Government issues of paper money. Upon the latter subject he said, in part:

"The emitting of paper money by the authority of Government is wisely prohibited to the individual States by the national Constitution; and the spirit of that prohibition ought not to be disregarded by the Government of the United States. Though paper emissions, under a general authority, might have some advantages not applicable, and be free from some disadvantages which are applicable, to the like emissions by the States separately, yet they are of a nature so liable to abuse, and, it may even be affirmed, so certain of being abused, that the wisdom of the Government will be shown in never trusting itself with the use of so seducing and dangerous an expedient."

The capital of the bank was to be $10,000,000, of which the United States Government was to subscribe $2,000,000, and be immediately reimbursed by a loan of the same amount, this loan to be repaid in ten annual installments. Hamilton wanted the Government to be a stockholder for a substantial amount, and in view of the state of its finances this was the only practicable way. Throughout the life of the bank the greater part of the stock was held abroad, a fact often urged against it by its political opponents. The directors, however, were required to be citizens of the United States. The head office was to be in Philadelphia, and branches were authorized anywhere in the United States. The charter ran to March 4, 1811.

The provisions governing the character of the bank's operations were simple and conservative. It was forbidden to deal in anything but bills of exchange and gold and silver. It might sell any part of the public debt received for its own stock, but

might not purchase any public debt without specific authority from Congress.

The proposal for a bank was alarming to Thomas Jefferson and his party. They thought that such an institution would be out of harmony with democratic institutions and likely to be more powerful than the young Government which created it. The opposition was mainly from the Southern States, and it is interesting to note that the opponents had an unfavorable opinion of the general utility of banking institutions. There had been none in the South to that time, and the need for them was not felt. Madison, a member of the House from Virginia, and Randolph, the Attorney General, opposed the measure upon constitutional grounds.

The bill passed and Washington, having satisfied himself that the measure was constitutional, signed it February 25, 1791. Thomas Willing, who had been president of the Bank of North America, became the first president of the Bank of the United States and held the place until 1808. Branches were established at Boston, New York, Baltimore, Washington, Norfolk, Charleston, Savannah, and in 1804 at New Orleans. The bank was ably and conservatively managed, and fully justified the representations of Hamilton as to the services it would be able to render to the Treasury and the public.

Unfortunately, the bank was involved in party politics from the beginning. Hamilton was a leader of the Federalist party and Jefferson a leader of the opposition. The Federalist party went out of power in 1801, Jefferson became President, and upon reëlection served until 1809. His own attitude toward the bank remained unchanged, but his Secretary of the Treasury throughout the eight years was Albert Gallatin, one of the ablest financiers of the country's history, and of a character so substantial and independent that he was able to maintain a disagreement with the President over the bank. Gallatin found the bank very useful. After the purchase of Louisiana he desired a branch office established in New Orleans to facilitate the operations of the Treasury in that locality. Jefferson demurred and wrote a letter to Gallatin which reveals the intensity of his feeling on the subject. He said:

"This institution is one of the most deadly hostility existing against the principles and form of our Constitution. . . . What an obstruction could not this Bank of the United States, with all its branch banks, be in time of war? It might dictate to us the peace we should accept, or withdraw its aid. Ought we then to give further growth to an institution so powerful and so hostile?"

Gallatin replied on the same date saying that the administration of the Treasury in the Mississippi region would be difficult and dangerous without the services of the bank, and that there were none but political objections, which, he added,

"lose much of their force when the little injury they can do us and their dependence on us are duly estimated. They may vote as they please and take their own papers, but they are formidable only as individuals, not as bankers. Whenever they shall appear to be really dangerous, they are completely in our power and may be crushed."

Jefferson yielded and Gallatin had his way. Jefferson's successor and political associate, James Madison, who had himself opposed the original charter, retained Gallatin as Secretary of the Treasury. The bank had now applied for a renewal of the charter, and through Gallatin's influence Madison was quiescent, Gallatin openly favoring renewal. The division in Congress, however, was mainly upon partisan lines, and the Jeffersonian party was in power in both Houses. The bill was indefinitely postponed in the House by a vote of 65 to 64, and failed in the Senate by a tie vote, with the Vice-President voting against it.

The total resources of the bank in January, 1811, were $24,183,046, of which $14,578,294 was in loans and discounts, $2,807,046 was in Government obligations and $5,009,567 was in specie. Its capital was $10,000,000, surplus $509,678, circulation $5,037,125, individual deposits $5,900,423, United States deposits $1,929,999. It liquidated in an orderly manner upon the expiration of its charter.

In the twenty years during which the first Bank of the United States was the leading banking institution of the country, banking under State charters had made important progress.

Statistics for this period are uncertain, but an estimate, in the report of the Secretary of the Treasury for 1836, gives the number of banks in all the States in 1800 as twenty-eight, with an aggregate capital of $21,300,000 and a note circulation of $10,500,000, deposits not mentioned. In 1831 Mr. Gallatin in a review of banking and finance estimated the number of State banks in 1811 at eighty-eight, with a combined capital of $42,600,600, note circulation $22,700,000 and specie holdings $9,600,000, deposits not mentioned.

The development of State banking up to 1811 was contemporaneous with and under the overshadowing influence of the Bank of the United States. The State banking systems were in the formative stage and their provisions for organization and regulation were very lax, but the big national institution furnished a sound currency and exercised a restraining influence upon State bank issues by presenting the notes for redemption. Much of the opposition to the renewal of the charter came from the State banks, but the antagonism from that source toward the first bank was not as intense as toward its successor.

Arrangements had been made for the organization of new State banks in all cities where the Bank of the United States had branches. In Philadelphia Stephen Girard bought the premises and business and became the leading banker of that city. In New York the Bank of America and City Bank were organized at that time. In Charleston the State of South Carolina established a completely owned State bank to take over the business. Altogether the liquidation of the big bank gave a great stimulus to the development of State banks, not only because of the business relinquished by the former, but because of the disappearance of the restraint which it had exercised upon other bank circulation. Mr. Crawford, Secretary of the Treasury, in a report to Congress on the currency in 1820, estimated the combined capital of all banks in 1815 at $88,000,000 and their circulation at $99,000,000 to $110,000,000.

The war with Great Britain was a factor in bringing about a suspension of specie payments in 1814, in New York, Philadelphia and generally except in New England. The suspension

facilitated an increase of bank issues, and the notes circulated at varying degrees of depreciation. The general state of the currency at this time was deplorable, and the Government was greatly embarrassed in financing the war. Mr. Gallatin, in his writings, published in 1831, gave his opinion that if the charter of the Bank of the United States had been renewed the suspension of specie payments would not have occurred and the country would have escaped the great losses incidental thereto.

When Congress met in 1814, sentiment upon the subject of a central bank had undergone a pronounced change. President Madison, once an opponent of such an institution, was now favorable to the establishment of a new one. Gallatin had retired from the Treasury to go abroad on a mission for the Government, but his successor, Mr. Dallas, took the position that a National bank was "the only efficient remedy for the disordered condition of our circulating medium." Opposition existed but the second Bank of the United States was chartered on April 10, 1816, for a term of twenty years. The terms were not radically different from that of its predecessor, but the capital was placed at $35,000,000. It was not opened for business until January, 1817.

The new institution was quickly involved in controversy with the State banks, over the transfer to it of the Government deposits and resumption of specie payments. In order to accomplish these ends the State banks were compelled to curtail credits and reduce their inflated issues, and although an effort was made to carry out the policy gradually, conditions were ripe for a financial crisis and it could not be averted. Prices fell, bankruptcies were prevalent and business was depressed over a number of years.

Gallatin's writings place the number of State banks in 1820 at 308, and the problem of dealing with them had become much more difficult than in the experience of the former Bank of the United States. The banks of that time were interested in increasing their note circulation, as the banks of a later time have been interested in increasing their deposits. They were inclined to regard the central institution which was always sending their notes home for redemption as their natural en-

emy. The Bank of the United States, however, was required under the terms of its charter to maintain specie payments and was obliged to accept the State bank notes which the Treasury was receiving for the revenues. It could not maintain payments of specie unless it received specie. Furthermore, the policy of promptly returning notes for redemption was necessary, as the only means of keeping the volume of issues within proper bounds. The restraining influence of both of the Banks of the United States upon the banking situation was decidedly wholesome. Many of the State bankers appreciated the value of that influence, but this was not generally true.

In 1829 Andrew Jackson came to the Presidency, and from his first utterance was hostile to the bank. Congress, however, was against him on this issue. In McCulloch *v.* Maryland the Supreme Court had settled the constitutional question, and in 1832 Congress passed a bill for renewing the charter, but Jackson vetoed and was reëlected as President upon the issue. Jackson forthwith directed the withdrawal of the public deposits and the designation of selected State banks as depositories.

The failure of the second Bank of the United States to obtain a renewal of its charter and the renewal of Government deposits to State banks were followed by an expansion of State banking similar to that which followed the liquidation of the first Bank of the United States. The second bank continued in business for some years, but it had lost its position of semi-official authority, and was a diminishing factor in the banking situation.

The time was one of general business expansion. Real estate speculation was on a great scale, canals were building and railroad construction was beginning. The new banks and the increasing currency issues were a stimulating factor. In 1831 Mr. Gallatin published a list of 328 State banks operating in 1829, with an aggregate capital of $110,101,898, aggregate specie holdings about $15,000,000, circulation about $48,274,-000, deposits about $40,781,000. These figures show only moderate expansion after 1820. The Bank of the United States at this time had in loans $31,000,000 and in circulation

$13,000,000. At the end of 1836 the number of State banks had increased to 788, their aggregate capital to $290,772,091, loans to $525,115,702, deposits $127,397,185.

This period of inflation culminated in 1837, with one of the most disastrous revulsions in the country's history. With few exceptions the banks throughout the country suspended specie payments, property became unsaleable, and business fell to an extreme state of depression. The extent of liquidation is shown by the fact that the aggregate amount of bank loans continued to decline until 1843, when it stood at $228,861,948, or less than one-half of the total at the close of 1836. The volume of currency declined in the same time from $149,000,000 to $58,563,608. Although the bottom was touched in 1843, but little improvement is shown by banking figures until ten years later.

The history of banking under State laws down to the establishment of the National banking system has been written so often that there is no need to dwell in detail upon the delinquencies and abuses of those systems. The general scarcity of money probably was a factor in the lax regulations of the early years, although ignorance of sound principles was mainly responsible. Apparently much antagonism to banks existed, but this was on the ground that they monopolized money, and instead of finding expression in more stringent regulations it seems to have prompted extreme liberality in granting charters and in policies of regulation, presumably with the idea of promoting competition and increasing the supply of money.

Capital subscriptions were payable as a rule in installments, and in many instances the banks began business with 5 to 15 per cent. of the subscriptions paid, after which the shares were pledged to the same institutions for specie or currency with which to make the later payments. Much originality was shown in devising means for preventing the presentation of notes for redemption. Banks were established in inaccessible places, and banks in different sections of the country exchanged notes for the purpose of getting them into circulation far from home. Public sentiment appears to have been tolerant of failure to redeem notes in specie, the opinion prevailing that an

adequate supply of currency could not be maintained if specie payments were strictly enforced. An instance is credibly reported of an attempt in Vermont to have a Boston broker indicted by a grand jury for attempting to collect payment in specie of the notes of a local bank. The legal penalties for failure to redeem were frequently very light, in some States consisting of a requirement that the date of presentation be endorsed on the note, after which it would draw interest, the bank continuing with its business.

The State systems were gradually improved as experience demonstrated their deficiencies, and in many states a high standard of excellence was established.

In New England the banks developed a system of current redemption for their note issues which deserves to be mentioned in contrast with the common efforts to avoid redemption. They established in the Suffolk Bank of Boston a redemption agency to which they promptly sent each other's notes as received. Thus redemption was effected by a clearing process similar to that afterward adopted for checks. Each bank paid none but its own notes into circulation and met its own notes at the Suffolk bank by sending in the notes of other banks for its credit. The effect was to regulate the issues of the several banks to the volume naturally belonging to them, for excess issues created adverse balances in the clearings which had to be settled in specie. The notes were being constantly redeemed and reissued, so that they bore a resemblance to cashiers' checks.

Moved by this practical demonstration of the true principle of currency issues the State of Massachusetts in 1843 in a new banking law forbade the banks of that State to pay out any notes but their own, and several other States adopted this policy. The Federal Reserve Act recognizes the principle in its provision forbidding any Reserve bank to pay out the notes of any other Reserve bank.

In 1838 New York State established a system of free banking, under which any group of applicants was granted a charter, provided it complied with the specified conditions. Previously all banks had been organized under special charters.

One of the new conditions was that note issues must be secured by the deposit of approved securities with the State Comptroller, and a similar provision was afterward incorporated in the National bank act.

In 1853 the capital, loans and circulation of the State banks were not yet back to the figures of 1837, but deposits were slightly larger. Then came four years of boom times. The placer mines of California were pouring out $50,000,000 to $60,000,000 of new gold annually, and foreign capital was building railroads in this country at the greatest rate yet known. Ambitious cities in the Middle West were planning for future greatness. The country was buying foreign goods on a scale which caused imports to exceed exports, and gold to flow abroad, which indeed was a natural distribution in view of the fact that the country had become the leading producer of the metal. The number of banks increased from 750 to 1,416 in four years, bank loans from $409,000,000 to $684,000,000 and circulation from $146,000,000 to $217,000,000. Specie was up from $47,000,000 to $59,000,000.

The strain upon credit resulted in a general crash in the fall of 1857. Many of the banks became insolvent, and with few exceptions even the solvent ones suspended specie payments. An action was brought against one of the New York banks at this time for the forfeiture of its charter under the terms of the State Constitution, but the Court ruled that the failure of a bank to redeem its notes in a time of general suspension should not be taken as evidence of insolvency, as redemption might be impracticable although its assets largely exceeded its liabilities.

Obviously a different ruling, which would have forced all of the suspending banks into liquidation, would have greatly aggravated the general disaster. The suspension of 1857 was of short duration, the solvent banks generally resuming specie payments in a few months, aided as they were by new gold supplies from California.

A notable development in banking was the establishment of the New York Clearing House in 1853. The immediate purpose was to simplify the daily settlements between the banks

of the city, and at that time more interest was felt in the clearing of circulating notes than in the clearing of checks.

The association of the banks in the new organization brought them into closer relations, and promoted coöperation in many ways. Within the first year of its existence it inaugurated the publication of the weekly Clearing House Statement, showing the average condition of each member during the preceding week, which has been continued to the present day, and always has been recognized as exerting a wholesome influence.

Ten times in the history of the New York Clearing House its members have virtually pooled their resources in order to make available to the business public the largest possible supply of credit and most effectually safeguard the general credit situation. The first of these occasions was in November, 1860, when the election of Abraham Lincoln to the Presidency of the United States, taken by the public as meaning that civil war was impending, precipitated a sudden disruption of business relations between New York and the South. Credit was paralyzed, the New York banks were drawn upon heavily, and faced the necessity of curtailing loans. In this emergency was devised the system of Clearing House Loan Certificates, used repeatedly since, as a means of settling the balances arising between member banks. The effect was to consolidate their resources, afford greater freedom in making loans, and reassure the public. One of the resolutions adopted at this time reads as follows:

"Resolved, That in order to accomplish the purpose set forth in this agreement the specie belonging to the associated banks shall be considered and treated as a common fund for mutual aid and protection, and the Committee shall have the power to equalize the same by assessment or otherwise."

This action brought immediate relief to a seriously strained situation.

At several critical times during the Civil War resort was had to this policy, and also in 1873, 1884, 1890, 1893, 1907 and 1914. The Boston banks established a clearing association in

1856, the Philadelphia banks in 1858 and the banks of other important cities soon followed. The policy of issuing certificates in times of crisis was generally followed until the Federal Reserve system provided the banks with a still more effective organization for mutual support. The Clearing House organization demonstrated the essential principle of a central bank of issue, and led the way to the adoption of the Federal Reserve system.

If a central banking organization had been in existence in this country in 1861, into which the Government's income from all sources was received, and from which all Government disbursements were paid, it is probable that the Civil War might have been financed without issues of Government paper money, and at much lower aggregate cost. The disjointed system of numerous independent banks, with their scattered reserves and lack of organization for coördinate action, was illy qualified to render the banking service which the Government's war needs demanded. Furthermore, the Treasury was hampered by the laws governing its methods. After the Treasury deposits had been removed from the Bank of the United States to State banks and heavy losses had been suffered by failures among these depository banks in 1837, a law known as the Independent Treasury Act was passed, establishing sub-treasuries in several sections of the country, and requiring all payments to the Treasury to be made in specie and the cash kept in the Treasury vaults. The increased volume of Treasury transactions in war time could not be handled under such conditions. The law was modified in a degree, but in the opinion of the Secretary of the Treasury not to the extent of allowing him a free hand in using the banks as a means of receiving, keeping and disbursing funds. The Clearing Houses of New York, Boston and Philadelphia coöperated in securing the distribution among their members and to the public of the first war loan of $150,000,000 in 1861, but the policy of removing coin from the bank reserves to the Treasury for subsequent disbursement made it impossible for them to continue such operations. The authorities at Washington concluded that it was impracticable to borrow money fast enough to meet

the war disbursements, and resorted to legal tender Government currency. Specie payments were suspended and bank notes and legal tender notes were soon depreciated and continued to fluctuate in value until the Government restored the legal tenders to par on January 1, 1879, when bank notes also were restored to par.

Salmon P. Chase, who became Secretary of the Treasury in the administration of President Abraham Lincoln, on March 4, 1861, in his first report, delivered in December, 1861, referred to the existing currency in the following language:

"The value of the existing currency depends on the laws of thirty-four states and the character of some sixteen hundred corporations. It is usually furnished in greatest proportion by institutions of least actual capital. Circulation commonly is in inverse ratio to solvency. Well-founded institutions of large and solid capital have in general comparatively little circulation, while weak corporations almost invariably seek to sustain themselves by obtaining from the people the largest possible credit in this form.

Secretary Chase regarded the legal tender act as a temporary expedient, and for a permanent solution of the banking and currency problem looked to a system which would bring all banks of issue under a national law. The original act called the "National Currency Act"—afterward called the "National Bank Act"—became a law in February, 1863. An effort was made to incorporate in it the best features of the various State banking systems.

The most notable feature was the provision that all note issues were to be fully covered by United States Government bonds. A similar feature in the New York law had seemed to work well, and this was expected to serve a double purpose in providing security for the note and helping the market for Government bonds.

The success of the National system was dependent upon inducing the State banks to join it, for it was not desired that the number of banks should be unduly increased. At first the State banks were disinclined to leave the systems of their own States, with which they were familiar, for a system governed

from Washington, with some of whose provisions they were not in accord. In 1865, to force the issue, the advocates of the system carried an amendment through Congress levying a tax of 10 per cent. upon all payments of State bank currency. The tax was intended to be prohibitive and had that effect. At the same time existing State banks were given a preference over other applicants for national charters and a strong appeal was made that they accept the law as a war measure and give their support to the Government. The result was a general shift to the National system, which forged ahead, and down to about 1900 held a decided lead over the combined figures of all banks and trust companies operating under State charters. Since 1900, however, the State institutions have shown an increasing lead over the National banks, due to the fact that until recently they were permitted a somewhat wider range of operations, and that in some States the minimum of required capital was less than that for National banks. The note-issuing privilege, once an important feature of banking, has become of little value, owing to the growth of the custom of making payments by checks.

DEFICIENCIES OF THE NATIONAL BANKING SYSTEM

The National banking system accomplished the principal purpose of its founders in supplying a national currency good without discount or question in every part of the country. The notes were so well secured that few people ever thought of asking for their redemption in any other form of money, but obviously it was impossible to provide similar security for deposits, and deposits had supplanted notes as the principal liability item in the banking business. Furthermore, the bond-security feature tended to make the volume of bank notes a fixed element in the monetary stock. In the later years, as a result of the reduction in the amount of government bonds outstanding, practically all of the eligible bonds were deposited for circulation all of the time, and the system had no expansive possibilities.

It was a serious defect in our monetary system that with the

exception of gold all of the various elements in our monetary stock were practically fixed in quantity. The needs for currency vary with the activity of business. The great bulk of payments in this country is made by means of bank checks, but lawful money is wanted for many purposes, and means should exist for the ready conversion of bank deposits into some form of currency. The elasticity of the currency hampered the banks in their ordinary business, but the most serious effects were realized in times of alarm, when the banks were subject to unusual demands for the payment of deposits.

The aggregate of bank deposits payable on demand was many times the total of all kinds of money in the country, and eight or ten times the cash holdings of the banks, yet no way existed of increasing the supply of lawful money except by importing gold—a process much too slow for dealing with emergency needs.

Of the solvency of the great body of banks in the country at any time there never has been a doubt, but with twenty-five thousand to thirty thousand banks under independent managements it has been inevitable that some of them would be mismanaged and get into trouble, particularly when periods of prosperity had caused a general expansion of credit. In every twenty years or less of the country's history periods of prosperity have ended in reaction and depression, as the result of imprudent use of credit, and unfortunately bank failures have been a feature of every crisis. Such failures tended to unsettle confidence and to cause demands upon all banks for cash, thus weakening the reserves and disturbing the entire credit situation. The losses directly due to insolvent banks were of small importance in comparison with the losses to all business resulting from the curtailment of normal banking service.

The banking system lacked organization for dealing with these emergencies. The reserves were scattered among the individual banks and could not be used effectively where most needed. Over and over again was demonstrated the need for facilities by which banking assets of unquestioned value might be converted into lawful money for the purpose of discharging bank liabilities.

The final demonstration of the inadequacy of the currency system was afforded by the general suspension of cash payments throughout the United States in 1907. The law-making powers then proceeded to take action.

The Federal Reserve Act embodies a policy based upon the banking experience of the world, but adapted to suit the somewhat complex banking situation existing in the United States. In most countries the currency-issuing function has been confined to a central banking institution, closely related to the Government, and by virtue of the power of note-issue serving the other banks as a resource for rediscounts and currency supplies. These institutions, although originally doing a general banking business, in late years have taken on more and more the character of central banks for bankers, acting as custodians of the gold reserves, guardians of the currency and foreign exchanges and charged with safeguarding the general credit situation.

This trend of development indicated what had been lacking in the banking organization of the United States. The two central banks of our history had been planned in form to serve like purposes, but their operations were competitive with the activities of the other banks to such an extent that first one of the former and then the other had to retire from the field. The Federal Reserve Act undertook to adopt the central bank idea but eliminate the factors of discord, by having the local banks, whether of the National or State systems, jointly own the central institutions, and by restricting the latter to business relations with their constituent members and the Federal Government, plus certain non-competitive operations. On account of the size of the country it was thought best to provide twelve Federal Reserve banks, each serving a territorial district and of independent organization, except that all are subject to the supervision, and within the provisions of the act, to the authority of the Federal Reserve Board, which is appointed by the President of the United States.

The practical effect of the plan is that the numerous, scattered and unrelated local banks, which were formerly unable to coöperate effectively even for the common defense, have

been enabled to create these Reserve banks to perform certain functions which the constituent banks separately were unable to perform. The first important accomplishment is the consolidation of the banking reserves in these institutions, which of itself would very greatly increase their effectiveness. The value of this consolidation of reserves is multiplied by the power to issue notes against gold and approved banking assets —a power which in view of past experience Congress was unwilling to grant to the thousands of local banks, subject to competitive conditions throughout the country.

It is unnecessary here to describe except in general terms the organization and functions of the Reserve Banks. They are primarily bankers to the United States Government and their member banks, and the final source of bank credit in this country. Dividends upon their stock are limited to 6 per cent., that their policies may not be influenced by considerations of profit. They are charged with administering the resources at their command with a view to maintaining stability in the banking and credit situation, so far as that may be possible. They are able to handle the heavy revenues and disbursements of the Government with the minimum of disturbance in the money markets. They make short loans to the Treasury to facilitate its operations. They rediscount eligible paper for member banks, thus meeting the variable needs for credit and currency, and also make short loans upon Government bonds. In order to have a degree of independence in their policies toward the money market, their operations are not confined wholly to dealing with their member banks, but they may buy and sell bills of exchange and Government obligations in the open market. In this manner they are able upon their own initiative to release money to the market in the event of stringency, or take money from the market in case of sudden plethora. Such operations have bearing upon interest rates, exchange rates and the market conditions which induce the exportation or importation of gold. Changes in the discount rates have similar bearing. The power of the Reserve banks obviously must be exercised with due regard for general economic conditions, but their position in the banking system

enables them to exert a steadying influence. The power of note-issue enables them to supply currency to their members so long as the latter are able to offer eligible collateral, subject to the requirements of the Reserve Act as to the reserves which the Reserve banks themselves must maintain against notes and deposits. Thus the situation is very different from what it was in the past times of panic, when practically no means existed for increasing the supply of lawful money except by importing gold.

The aggregate gold holdings of banks and public treasuries in thirty-five countries at the close of the year 1926 was $9,181,000,000, of which above $4,000,000,000 was in the United States, and approximately $3,000,000,000 was under the control of the Federal Reserve banks. A suspension of payments by the Reserve banks is inconceivable, and therefore anything like a general suspension by the member banks is inconceivable, as such suspensions in the past have been due to the inability of solvent banks to obtain currency.

The fact that banking in the United States has been organized in part under National and in part under State authority has been responsible for many of the complexities and difficulties that have been experienced. It has tended to multiply the number of banks and to prevent the development of a unified system. The multiplication of small units has been a fundamental weakness in the banking situation.

This weakness has not been wholly remedied by the Federal Reserve System, for while the banks of the National system are required to join there is no compulsion upon other banking institutions. On June 30, 1926, 20,168 banks other than National were reported by the Comptroller of the Currency, with aggregate resources of $39,577,738,000, of which only 1,403, with aggregate resources of $15,543,000,000, were members of the Federal Reserve system. Many of these banks were ineligible, on account of size or the character of business done. Many of them are below the minimum amount of capital required for admission to the Reserve system ($25,000), which properly raises the question whether communities whose requirements are so small would not be more

effectually served by branch offices of near-by banks of larger resources and holding memberships in the Reserve system. In but few of the States, however, is branch banking permitted under the laws. National banks are permitted to have branch offices only in States where the State banks are granted that privilege, and then only within the city in which the head office is located.

Notwithstanding the difficulties under which the bankers have labored in the past, due in large part to deficiencies of the banking laws, banking in this country has made wonderful progress. It has kept pace, as indeed it must, with the growth of wealth and business.

The National and State systems, under which the banks doing business with the public are organized, have been administered with increasing efficiency, and the Federal Reserve system is the cap stone of the structure.

The growth of individual deposits in the several classes of banks since 1880 is shown below:

(All figures in thousands of dollars, 000 omitted)

Year	*Total*	*National Banks*	*State Banks*	*Loan and Trust Companies*	*Private Banks*	*Savings Banks*
1880	2,134,235	833,701	208,752	90,008	182,667	819,107
1890	4,060,803	1,521,746	553,055	336,456	99,522	1,550,024
1900	7,238,986	2,458,093	1,266,735	1,028,232	96,206	2,389,720
1910	15,283,396	5,287,216	2,727,927	3,073,123	124,644	4,070,486
1920	37,315,123	13,705,325	10,836,188	6,065,967	169,449	6,538,194
1927	51,132,554	18,239,353	12,936,590	10,094,485	123,224	9,862,126

The increase as shown by the figures from 1914 to 1920 is exaggerated by the inflation of credit and prices, but the showing since 1920 has been diminished by a decline of prices. In the thirty years from 1880 to 1910 the growth of deposits was approximately 700 per cent., while the growth of population was approximately 80 per cent. Since then the influence of war financing and price changes have been so great that comparisons are of little value.

The aggregate of the resources of all banks in the United States reporting to the Comptroller of the Currency as of June 30, 1927, was $68,132,558,000. These figures include only

banks accepting deposits from the public. The Federal Reserve banks, Federal Land banks, Intermediate Credit banks are not included, nor are the deposits of the United States Postal Savings System. The latter on June 30, 1927, amounted to $155,901,000.

The number of banks of each class reporting as above was as follows:

National banks, 7,796; State banks (commercial), 15,690; Loan and Trust companies, 1,647; private banks, 467; Stock Savings banks, 843; Mutual Savings banks, 618.

The Economic and Financial Section of the League of Nations has published recently a compilation of banking statistics, as of the end of 1925, for thirty-five countries, which affords a fair basis for a comparison of the volume of banking operations in the United States with those in the other countries. The total of bank deposits and currency issues in the thirty-five countries, converted into dollars at current rates of exchange, was $98,715,000,000, of which sum $56,159,000,000, or 56.8 per cent., represented the share of the United States. The figures for this country do not include agricultural credit banks or the postal savings system.

Prior to the Great War, American banks had but slight participation in financial operations outside of the home country. Our own export and import trade was financed almost wholly by means of bills of exchange drawn on foreign bankers, London being the chief money market for such operations. Thus a New York merchant desiring to import coffee from Brazil would have his own banker arrange with a London bank to accept a sixty- or ninety-day bill of exchange drawn by a Brazilian exporter for the value of the coffee shipment, and the bill would be carried to maturity on the London market. At that time the New York merchant would have the funds ready with the accepting bank to meet the obligation. American exports to all parts of the world were financed in a similar manner.

With the establishment of the Federal Reserve banks systematic efforts were begun to develop a bill market in New York which would afford a constant supply of funds on a com-

petitive basis with London, for bills secured by shipping invoices or warehouse receipts. The object was to develop the currency of commercial paper of the highest and most liquid form. The Federal Reserve banks have supported the effort by standing ready to buy such bills at preferential rates and a call money market for this class of paper was established. The American Acceptance Council was organized in 1919 "for the purpose of conducting and directing a nation-wide educational campaign designed to inform the business people and bankers as to the merits of bankers' and trade acceptances, the method of their use in foreign and domestic merchandising, also to aid in establishing a comprehensive open discount market, and to assist in other matters that will improve the credit system and strengthen the financial position of America."

The movement has had a gratifying degree of success, being favored by the fact that in recent years current interest rates in New York have been lower than in London or other financial markets. In the year ending September 30, 1927, approximately $5,044,000,000 of business was financed by means of American bankers' acceptances, of which 38.2 per cent. covered imports into this country and 34.7 per cent. covered exports from this country; 14.3 per cent. were issued against goods stored in independent warehouses in this country; 2.7 per cent. represented domestic shipments and 7 per cent. represented goods stored abroad or shipped from one foreign country to another. At this writing the volume of acceptances outstanding in the United States as reported to the Acceptance Council is in excess of $1,000,000,000, which compares with an estimate of approximately $1,500,000,000 on the London market before the war.

Branch banking never has been in favor in the United States, and until the Federal Reserve Act was passed no Federal authority existed for the establishment of American branch banks in foreign countries. The Reserve Act provides that any National bank with a capital and surplus of $1,000,000 or more may file application with the Federal Reserve Board for permission to exercise, upon such conditions and under such regu-

lations as may be prescribed by the said Board, either or both of the following powers:

First. To establish branches in foreign countries or dependencies or insular possessions of the United States for the furtherance of the foreign commerce of the United States, and to act if required to do so as fiscal agents of the United States.

Second. To invest an amount not exceeding in the aggregate ten per centum of its paid-in capital stock and surplus in the stock of one or more banks or corporations chartered or incorporated under the laws of the United States or of any State thereof, and principally engaged in international or foreign banking, or banking in a dependency or insular possession of the United States either directly or through the agency, ownership, or control of local institutions in foreign countries, or in such dependencies or insular possessions.

Under these provisions American banks have established and now maintain 109 branches in 18 foreign countries. Ninety-two of these are branches of the National City Bank.

An impressive demonstration of the growth of the financial power of this country has been made since the outbreak of the war in 1914. Until that time the available new capital accumulations of our people had been invested almost wholly at home for the development and expansion of our own industrial resources and in the various forms of wealth directly serving the people of this country. Furthermore, we were largely indebted abroad on capital account, the aggregate holdings of Europe in the United States in 1910 being estimated by competent authorities at about $5,000,000,000. The investments of our people abroad at that time probably did not equal one-third of that sum. The Department of Commerce has estimated the total investment of foreign capital in the United States at the end of 1925 as $3,000,000,000, and that a net increase of $300,000,000 occurred in 1926. The Department of Commerce also estimates that at the end of 1926 the investments of the American people abroad aggregated $11,215,-000,000, and the reported flotations of foreign securities in this country in 1927 indicate an addition of about $1,300,000,000

to these figures. Inasmuch as the United States, by reason of its great productive capacity, is accumulating capital with unparalleled rapidity, and interest rates prevailing here are lower than in any other capital market of the world, it may be expected that our investments abroad will continue to increase.

XIV

INDUSTRIAL COMBINATIONS (TRUSTS)

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A SURVEY of the last one hundred years of industrial progress must be based largely upon a study of each individual industry as a unit. But the course of industrial development presents many similar tendencies in its various parts. Industries have not been independent of each other, but rather, the developments in all have tended to be uniform. The particular development with which we are here concerned and which has been one of the most important features in the history of American industry has been variously referred to as the "Combination Movement," the "Trust Movement," and the "Era of Monopolies."

The confusion of terms has been the result more of the simultaneous adoption of varied phrases by different writers, than of any fundamental confusion of thought. Under the circumstances, a brief analysis of terminology will serve to clarify the subject without departing from the established principles of the chief students of the problem.

"Industrial Combinations" is a phrase used to refer to that marked centralization in the ownership and control of many of the important industries of the United States, which has taken place during the last fifty years. Strictly interpreted, the phrase would have to include any union of two or more competitors, however small, and the period included would be considerably longer. But controversial interest in and discussion of the subject have centered upon one phase of the com-

bination movement wherein the combined enterprises in any industry acquire the power to affect prices. Such a combination is more properly called an industrial monopoly or trust. The word combination does not always mean trust, since it is evident that many combinations may exist in a single industry, in which no one has a monopoly of the business. A trust, then, is any person, corporation, or combination of persons or corporations, which controls a sufficient portion of the supply of a commodity to be able to affect the price in its favor. There is no complete monopoly needed. This form of control of industrial enterprise has been characteristic of many of the most important industries of the United States, and its tremendous power for good or evil has engaged the earnest attention of the thoughtful members of society up to the present day.

It was long ago stated by Stephenson that where combination is possible, competition is impossible. That, however, in these days has a very wide application. Stephenson, of course, used it in connection with railways only. In these later days the possibility of exchanging information by telegraph, telephone, and even by radio, has made feasible the management as one unit of widely separated industrial establishments, and this has very greatly increased the power of combinations.

We need to distinguish two kinds of industries peculiarly adapted for combination. Goods of a standard quality ordinarily sold in large quantities to consumers are in one class. Sugar, salt, alcohol, can all have the quality readily tested. In consequence, competition becomes largely a matter of price. Goods that can be given a certain brand and soon become familiar to buyers also come under this class; for example, the Kodak, Shredded Wheat, Royal Baking Powder, or certain brands of tobacco may be immediately recognized by the customer, and the manufacturer finds that it pays to maintain the uniform quality of the brand. In consequence, these industries may readily be put into one class.

Those of the second class find their advantage in savings in the costs of the product or of selling, so that by combination the entire industry gets the benefit over any individual industry. Let us note some of these savings in costs:

If one establishment happens to be located, we will say, near Chicago, and another rival establishment near New York, each will naturally ship goods into and beyond the territory of the other; whereas by a combination each would ship products only in its own neighborhood and would leave the field about the other's establishments open to his shipments. In this way, many cross freights would be saved.

On somewhat the same principle, instead of a number of rival salesmen all visiting the same establishment with like goods, one salesman only would visit each separate establishment with practically all of the brands put out by the combination. Thus there would be a very great saving.

An examination of the pages of any of our popular magazines furnishes an illustration of the saving that could be effected in advertising. Note the rival automobiles that are sold. When they are separate companies, the advertisements need display and space. As long as the automobiles are of a somewhat different class, when they are in one company, as in the case of General Motors, they need to be enumerated; but even here there is an opportunity for making bargains with the newspapers and magazines, and a great deal less space can be used in enumerating the different classes with prices than if one had to take a full page for each separate automobile.

In the same way, various brands of soaps, tobaccos, face powders, fountain pens, and numerous other articles of the same class may be mentioned, wherein the savings are very large.

The large establishment has also a distinct advantage from its accumulation of capital. This would be especially true in connection with foreign markets. To introduce an article into another country requires often a very large outlay, which a small establishment could not undertake. It costs, for example, many thousands, even hundreds of thousands of dollars, to introduce widely into a new country a new automobile. The same thing may be said with reference to new brands of tobacco and cigarettes. A small establishment could not undertake this expense.

Of very great importance, too, is skillful management.

Often the entire difference between profits and ruin depends upon the manager. In the case of a combination of different establishments, it is possible to select from a group of highly trained men the best one of all to be a general manager. Again, it frequently happens that there are a number of allied industries; one manager would be especially skilled in one industry, another would know a second industry, and so on. In the case of a combination, the plants would be so arranged as to enable one line of goods to be made in one establishment, another in a second, etc.; whereas, if the industries were smaller, it might be essential that all be manufactured in one plant. In this way, not only can the managerial skill be better directed, but also the productive capacity of the various plants can be utilized to the best advantage, and this makes a very large saving. Moreover, where there are different plants in the same establishment, competition among the managers becomes very keen, even more so than in the case of independent industries, because the knowledge of one another's work can be much more accurately measured. It is the custom to have frequent reports (daily, weekly, monthly) from each of the several establishments. A comparison of the reports from these establishments will show in just what particular each plant excels; in one it may be the cost of labor per unit, in another a saving may be made in the raw material, in a third the routing of the product through the plant may be better. Attention would be directed to the special point of strength of each individual manager, and thus the stimulus would be far greater than in the case of individual establishments.

In many cases also the combination can hold individual customers much better than can individual plants. I have already spoken of the distribution of allied goods among different plants so as to effect savings. In the same way, if orders come in for a great variety of goods, when the orders are received they would be distributed among the different plants so as to furnish the customer in each case at the lowest cost. If an order had to be distributed and cared for in one plant, as, for example, a rolling mill, this might very easily cause the stoppage of the plant and the changing of the rolls

a number of times so as to complete the order. This changing of the rolls could be avoided by the distribution of the order itself among the different plants. Furthermore, if through one establishment a customer can have all of his needs in any line filled, it is a benefit to him. Here again comes the advantage from the large combination. Customers will prefer, other things equal, to deal with an establishment that controls from 75 to 90 per cent. of the output if they can be sure of having their needs filled by such an establishment. In this way the American Sugar Refining Company, because of the regularity of its supply, sometimes secures, say, one-sixteenth cent a pound more for sugar on account of the certainty with which the orders can be filled.

Frequently, too, the large establishment is able to secure a better type of credit men and to handle its credits in a wiser way than the small establishments. Sometimes the managers of the smaller concerns will grant credit somewhat unwisely; moreover, they hesitate to bring needed pressure upon those who owe them money, so that their losses from bad debts are somewhat larger than is the case with the large establishment.

Combination frequently used to be brought about on account of special favors granted by other establishments. This is probably no longer true in quite the same sense that it was earlier, but nevertheless it is a point to keep in mind. Some of our largest combinations were brought into existence by the fact that they could get special discriminating rates of freights from the railroads. There can be little doubt that the railroad itself had a decided advantage from the large customer, so that it could afford to give the favor. That, however, has been held by the courts to be contrary to public policy, and in consequence it has been largely eliminated.

It is probable also that our protective tariff, by putting up a bar against the competition of foreign manufacturers, has forced a more severe competition within the country itself and has in that way led to combinations. The tariff in this way gives encouragement, although it can hardly be said to be a cause. The combination itself would doubtless survive without the tariff unless the entire industry so rested upon the tariff

that it would be destroyed if the tariff were removed. In a good many instances, however, lowering or removing the tariff might prevent exorbitant prices.

Doubtless the growth of combinations has often been facilitated by the desire of the promoter to make profits. If a combination is likely to be a successful one, the promoter, by visiting from fifty to one hundred different establishments, winning the confidence of the managers and owners and maintaining secrecy wherever that is desired, may bring the different factors together. This, however, is a difficult task and one that often requires several months' work. Moreover, it is a task that is likely to fail. The consequence is that the promoter should receive large rewards, and this he frequently does. Ordinarily, in the case of a large combination, he takes his pay in the common stock of the establishment, thus assuming an additional risk; but the total amount given to the promoter may well be large, as it should be. The consequence is that by successfully putting together one or two combinations a man may be made financially independent.

It is frequently the case in making combinations that owing to the depressed condition that has come from competition, new capital is needed in rather large amounts. If the combination is effective, the poorer establishments will be largely eliminated, and beyond any doubt the extent of the competition will be decidedly lessened. This can be done even under the law as long as a goodly measure of competition still remains. The banks furnishing the new working capital are likely to demand and to receive in the form of securities very high pay for their services.

It is possible for the combinations, from the savings which they effect, to expend more money in wages per man than could be done by the constituent companies. In a good many instances, as we have seen, certain classes of workmen such as commercial travelers and also various superintendents might be dispensed with, thus lowering the total amount of wages paid. It is, however, not usual for any employer to increase wages without a certain amount of pressure or at any rate of asking on the part of the employees. In certain cases, owing to the

advantage of the combination, somewhat less skilled labor can be employed; as, for example, in the case of salesmen. When competitive selling is largely done away with, a somewhat lower type of salesman might be employed merely to show the goods of the combination. As a rule, however, this would not be true. The better skilled men in all lines should be employed even though the total number were reduced.

In the case of disputes between the employer and his employees, there is a decided advantage coming from the combination. Orders may be shifted from one plant to another, so that a strike, even extending over several establishments, will not cripple the industry. Orders can be transferred to plants that are still running. In certain extreme instances a large combination has even dismantled a plant and transferred its business entirely to other establishments. On the whole, however, on account of the greater regularity of employment, it is probable that the combination movement has tended toward an increase in wages the country over.

From the various sources of savings that have been enumerated, a trust may affect prices in two ways. It may pay somewhat more for its raw materials and it may sell for somewhat less its finished product.

When a trust buys its raw material from outsiders, the fact that its cost of manufacture has been lowered somewhat, and the fact that there may be from time to time a decided increase in the output will lead it to pay a somewhat higher price for the raw material that is used. More frequently, however, the combination, especially of late years, has been able in many industries to purchase the source of its raw material, making in this way the so-called vertical trust, by which it sometimes manufactures the entire product through a series of processes, from the raw material to the often complicated finished product. A very striking instance of this is found in the case of an individual—Henry Ford—who owns iron and coal mines, railroads, and now is preparing to grow his own rubber. In this way all of his unfinished products probably can be manufactured more cheaply than they could be bought.

It is practically certain that in the long run combination will

tend toward a stabilization of prices. That has certainly been the case with the Steel Corporation, and it is likely to be the case generally. Stabilization of prices is in many cases as important as a somewhat lower price would be. Orders have frequently to be given for a considerable time in advance; for example, a railway will put in an order for steel rails months before it is going to use them. The same thing holds with reference to many of the steel shapes that are employed in building; likewise also in shipbuilding, where frequently the steel used in either plates or ribs or otherwise may have to be made specially to order. In these cases prices need to be fixed often months in advance and the goods must be delivered at the time that they are wanted. Under such conditions, naturally the purchaser can afford to pay somewhat more for the certainty of security as regards quality and time of delivery.

From the savings mentioned above, it is clear that there can be a considerable lowering in prices without lessening the profits. In fact, before the combination was made, competition was so fierce that often all producers lost for a time.

The history of the development of American manufacturing industries, insofar as their organization is concerned, has since about 1875 been largely the history of trusts. A study of this development ought particularly to examine the economic and political forces which underlay the movement toward monopoly and which explain the evolution in form of industrial control.

The influences which resulted in the beginning of trust formation were in existence for some time previously. It may fairly be said that these influences or causes were of three kinds.

First: There was a set of influences which might be called *attractive*. Among these was the widely observed success of the great movement toward large scale production and combination which had its beginning during the Civil War period. This was a competitive development, and took the form of a tremendous increase in the size of manufacturing plants. From 1850 to 1880 the average capitalization per manufacturing establishment increased more than eight times, the average number of wage earners employed, more than three

times, and the value of the products, more than seven times. This phenomenal growth of large-scale industry depended in turn upon several important economic forces prevailing during this period. Chief among these forces were the tremendous growth of population, augmented by heavy immigration from Europe, and the accompanying westward movement of settlers. These developments, with the nation-wide extension of railway transportation, afforded a continental market for manufactured products. The numerous inventions leading to improved communication, such as the telegraph and telephone, had no small share in the development. On the technical side, the invention of labor-saving machinery, and the consequent economies of large-scale production of specialized products, which we have already discussed in some detail, made the expansion of plant feasible.

There was then a well-defined and widespread expansion of industry to encourage the trust development which followed. Added to this was the attractive possibility of securing monopoly profits if sufficient control of the industry could be secured.

Second: There was a strong compelling influence toward trust formation in the marked decline in prices which lasted from 1865 until 1896. Competition under such conditions necessarily became very intense, with the result that profits were reduced to a low figure for the most efficient, while the remaining producers suffered losses. Naturally the captains of industry were willing to adopt any expedient that promised to maintain prices, and therefore profits.

Third: Given such incentives to restraint of competition, trust formation only needed favorable conditions to develop rapidly. Such conditions were not lacking. The growth of large-scale production had concentrated the major part of most industries in a few hands, so that agreement between these competitors was easily effected. A supply of ready capital, welcoming opportunity for profitable investment, and the absence of any serious legal obstacles, both contributed to monopoly development.

The history of the development of trusts may roughly be

divided into four periods, on the basis of the predominance of certain forms at certain times. The first period may be regarded as extending from 1870 to 1890, approximately, during which time simple forms of trusts prevailed.

The earliest attempts to restrain competition in the decade 1870-80 were simple, informal agreements between competitors with a view to restricting output or refusing to cut prices. These soon gave place to more formal agreements known as pools, of which there were several kinds. The essential feature of this arrangement was the retention of the individuality of the participants, coupled with a fairly effective control over output. These organizations were adopted in many of our chief industries and this method of market control is still used in a few cases. But it was most popular from 1870 to 1890, and included such industries as anthracite coal, cotton bagging, copper, whiskey, steel rails, iron pipe, wire nails, meat packing, tobacco, glass, and many others. But this form of trust was difficult to maintain, especially in the face of declining prices, when, without sufficient centralized control, it was profitable for the individual firm to break the agreement. Furthermore, under the common law, pooling contracts were unenforceable.

Chiefly for this reason, most of the pools were succeeded by a new form of monopoly, the so-called "trustee device." Under this arrangement, the stockholders of the combining corporations exchanged their stock, according to the value, for trust certificates. The stock was held by a Board of Trustees, which issued the certificates and which managed all the constituent enterprises, with the purpose of securing as far as they could, though often far from it, a monopoly price. Pro rata profits were distributed by the trustees to the original stockholders, in proportion to the trust certificates held.

The first trustee device was employed in 1882 by the Standard Oil Company. From this device the word "Trust" came to be applied to nearly all forms of monopoly. This was followed by the organization of similar trusts, in cotton oil, linseed oil, whiskey, sugar, lead, cordage, and other products. It had the advantage of centralized control over voting power, and was permanent in nature.

The wide adoption of the trustee device was followed almost immediately by public opposition, which expressed itself in two forms. Many States passed anti-trust legislation after 1887, and in 1890 the Federal Government enacted the Sherman Anti-Trust Law, which specifically forbade any combination in restraint of interstate or foreign trade, or any attempt to monopolize such trade. It is worthy of note that there was formulated here a policy which might be applied to any form of trust adopted in succeeding years.

Meanwhile, many of the existing monopolies operating under the trust device were prosecuted without resort to the new legislation. It was pointed out by the attorneys-general of several of the States that a corporation in submitting to the control of a board of trustees was acting beyond the powers granted to it in its charter. The Sugar Trust and Oil Trust were thus charged with acting "ultra vires," and this form of monopolistic control was destroyed by the courts.

But the economic forces tending toward the monopolization of industry were stronger than ever in the last decade of the nineteenth century. Popular opposition, while powerful enough to embarrass seriously the current form of monopoly, only caused the trusts to assume new and less vulnerable forms. The ensuing trust activity was of such a distinctive character that the period of time involved may properly be designated as the Middle Period. It extended approximately from 1890 to 1915.

The two dominant forms of trust in this period were the holding company and the so-called "Great Corporation" or property-owning trust. With few exceptions the industrial monopolies adhered to one or the other form, many changing from one to the other as conditions seemed to warrant.

The holding company was substantially a "trustee device" under new legal guise. The stockholders of the constituent corporations received stock of the controlling corporation rather than trust certificates, and the operation of the enterprise was controlled by the board of directors of the holding company, instead of a board of trustees. The property-owning trust or "Great Corporation" was formed by the outright pur-

chase of the properties of the constituent corporations, either for cash or for the stock of the trust, which was either one of the former competitors, or a new corporation formed for the purpose.

The transition from the older forms to these new vehicles of monopoly power was, of course, not immediate. Several important industries, like that of oil refining, were conducted without competition under a "community of interest" plan, feasible where family relationships or close friendships among the principal competitors made coöperation possible. But this was a temporary expedient, even in the few instances where it was employed. Very soon after the older forms of trusts became impractical, the important industries of the country were reorganized under the newer forms.

The "Great Corporation" or property-owning trust was the more popular form during the period 1890-97, largely because it began to be adopted and proved a financial success before the holding company form was made legally possible by state legislation. During the period mentioned, the production of cordage, cotton oil, matches, tobacco, whiskey, starch, sugar, wall paper, leather, malt and glucose products were largely monopolized under this form of trust.

It was from 1898 to 1900, however, that the trust movement of the middle period reached its height. During these three years the manufacture and sale of tin plate, tobacco, silver, paper, linseed oil, electric elevators, oil, shoe machinery, steel wire, steel tubes, bicycles, chewing gum, asphalt, glass, salt, sanitary plumbing, cotton yarn, cotton duck, sheet steel, and snuff, were brought under the control of trusts, chiefly of the property-owning type.

During this period the holding company began to be adopted, after New Jersey had led other States in the passage of enabling acts. The Standard Oil Company of New Jersey (1899) was the outstanding leader in the movement.

Between 1900 and 1904, a somewhat less intense era of trustification ensued, mainly taking the form of holding companies. During this time were formed the United States Steel Corporation, the American Can Company, the Interna-

tional Harvester Company, the Corn Products Company, and the International Nickel Company. Reorganizations, chiefly under the holding company form, also took place in the tobacco, camera, salt, cotton duck, whiskey, coal products, powder, asphalt, and meat-packing industries.

By this time most of the industries in which the success of monopoly control could be expected were organized under some form of trust, chiefly the forms we have mentioned. The ensuing ten years witnessed lively activity of the existing trusts to secure the results of their efforts. A few new trusts were formed, many failed, and several were dissolved during this period.

We should naturally expect that the consuming public would not let this monopoly development go unchallenged. In tracing the history of trusts, we are not primarily concerned with an evaluation of industrial monopolies in terms of their effects upon society. That is a wider question. But insofar as the people of the United States have developed a definite attitude toward trusts, which has been a powerful force affecting their development, the public attitude must be included in a proper historical survey.

We have noted that the public attitude had developed into one of strong opposition even before 1890, and that it had taken the form of a nation-wide anti-trust program of legislation, culminating in the Federal Sherman Act. For a while thereafter, public interest in the trust problem seems to have waned, probably due in large part to the widespread belief that the existing legislation would solve the problem in the public interest. But the tremendous activity in trust formation and operation in the period 1897-1904 apparently convinced the majority of consumers that their solution was not effective, and that their interests, as they thought, were being jeopardized more than ever before. The development of such an attitude was by no means sudden, but rather took the form of a gradual, belated awakening to the new issue of monopoly control of industry, which gathered force as the first decade of the twentieth century unfolded.

If the newly awakened public opposition to trusts was due to

the increased activity of industrial monopolies and their wider extension, the explanation of this development must be sought in the failure of the existing legislation to accomplish its purpose. Evidently the failure lay not in the wording of the Sherman Law, which was as drastic as it well could be, nor in the failure of Congress to maintain an anti-trust policy. It is to be found in the kind of enforcement given the law by the machinery charged with this duty, the attorneys-general and the Federal courts. A review of the prosecutions entered against alleged monopolies accounts for a good deal of the failure of the anti-trust policy. Out of the many indictments of this nature, relatively few were made against the trusts existing openly in the most important industries. Almost none of them were prosecuted before 1895, and few before 1904. A large proportion of the cases had to do with labor unions, against which the Sherman Act is claimed by many never to have been intended to operate, and with railroad consolidations, which have since been encouraged, subject to careful administrative control.

Most of the outstanding trusts then were never prosecuted before 1911. In the case of those which were indicted, the decisions of the Supreme Court were such as not seriously to discourage the process of trustification. The acquittal of the Knight Company in 1895, really due to the incompetence of the prosecution, was popularly taken to mean that the Court would regard "restraints of trade" as restraints upon intrastate manufacture, over which the Federal Government had no control. It was not until 1899 that the Court decided against an industrial monopoly, when it held the Addyston Pipe Company to be acting in restraint of inter-state trade. This was a distinct blow at pools, but it did not affect the new forms of trusts, under which many of the chief industries had by that time been organized. In 1904, by the Northern Securities decision, the Supreme Court did display a disposition to interpret the Sherman Act in such a way as to dissolve existing trusts organized as holding companies, and to discourage the formation of new ones. But the "Great Corporation" remained untouched until much later.

In 1911, by the decisions in the Standard Oil and Tobacco cases, it was made apparent that the Court would apply the Sherman Act to any form of trust, but in the opinion of many the policy of condemning only the kind of industrial control which exercised an *unreasonable* restraint upon interstate commerce considerably lessened—and wisely—the Federal power to eradicate monopoly. A corporation acting reasonably and in the public interest might well expect to be upheld.

During this time, as we have said, the public interest in the problem was increasing. Reformers, public administrators, and legislators of State and nation indulged in vehement denunciation of the trusts, and the public press was filled with schemes for their removal or control. Gradually two schools of thought arose as to the policy to be pursued. A considerable number favored the idea of encouraging monopoly wherever it proved successful and of limiting its power for evil by an efficient public regulation of its practices. Those opposed to monopoly, believing that trusts, even if controlled, were not socially advantageous, and skeptical of the possibility of successful regulation, declared for a rigid policy of destruction of existing monopolies and prevention of new ones.

This controversy bulked large in the presidential and congressional campaign of 1912. The Democratic Party, committed to effective dissolution of existing trusts and the wise prevention of new ones, was victorious, and proceeded in 1914 to embody the new policy in legislation.

The Federal Trade Commission Act declared unfair methods of competition to be illegal and created an administrative board of experts to investigate and regulate trade practices, advise corporations as to proper procedure, and make public all cases of existing or potential trusts. This board was thus to assist in the conviction and dissolution of existing monopolies and, in its advisory capacity coupled with a power to compel cessation from unfair competitive practices, to prevent the formation of trusts.

The Clayton Act defined and confirmed already existing antitrust legislation, specifically prohibited certain unfair competitive practices, and provided for penalties for violations of its

provisions in the form of governmental suits, and individual suits for damages or for injunctive relief, supported by evidence obtained in governmental suits.

It may fairly be said that the legislation of 1914 did three things: (1) It maintained and emphasized the government policy of opposition to trusts in any form; (2) it completed a well-rounded program of activity in the furtherance of this policy, proceeding along two lines: (a) the breaking up of existing trusts, (b) the prevention of new ones; (3) it afforded an effective (if properly used) machinery for the carrying out of the government policy in the directions indicated.

The leading students of the trust problem attached importance to this legislation, and were interested in following the administration of the new policy. The year 1914, under normal conditions, might have marked an almost revolutionary change in the course of the development of industrial control. If the new machinery could have devoted its undivided attention to the tremendous task at hand, and if interested parties, especially the influential students of the problem, could have observed with critical eye and ready comment the social results of the new policy, the evil trusts might by this time be nonexistent, while the good ones might be progressing in power for social well-being, with the public interest maintained by watchful control. But circumstances dictated otherwise. The Great War, which had unsettling effects on many aspects of industrial development, was a particularly disrupting influence in this field of activity.

The advent of war modified the trust problem in many ways. We can trace its influence in the economic forces operating, in the circumstances surrounding the governmental activity, and in the public attitude. As to the first, if there had been a need for consolidation of industrial control before, in terms of productive efficiency, the need under war conditions was even greater. The pressing urge was for tremendously increased production, the full utilization of resources, capital and man power. Throughout the industries most vitally connected with the struggle, there developed an increasing tendency to find the

man who could coördinate an industry and to give him absolute power. Indeed it is claimed by many that the previous existence of trusts in many lines of industry greatly facilitated production under war pressure. The government itself, recognizing the need for coöperation, took over the control of vital industries and operated them for maximum production without regard for demarcation in ownership or the maintenance of low prices.

No more striking example of the change in government policy can be had than the case of the railroads, which had long been under suspicion, and which the courts had tried to maintain on a competitive basis. These were immediately (as the first act of the Secretary of the Treasury in his new capacity as Director of the Railroads) taken over and amalgamated into one great nation-wide system, under government direction.

The public attitude was bound to be influenced by the changed conditions and by the different policy with which industry and the government met the situation. Instead of regarding the Captains of Industry as engaged in a conspiracy to starve them at high prices, the consumers came to regard these leaders as essential cogs in the war machine and coöperated in the process to the extent of revising their standards of consumption. It was the case of a new paramount issue dwarfing all others in the center of public interest.

It is not surprising to find an after-war tendency to continue in the mental habits of the war period. Public opinion is slow to form on any subject. Our survey has indicated that when the trusts were exceedingly active and no distractive influence prevented public attention being given to them, general interest in the subject lagged considerably. Habits of consumption and price standards acquired during the war period, together with the emotional exhaustion following the harrowing years of conflict, account in large part for the fact that renewed public interest in trusts has been very slow to develop. Only within the last three or four years have even injured parties been moved to audible protest. Many of the outstanding students of the problem have turned their attention to other fields.

Little has been written, and little more been said concerning the development of industrial control within the last ten years. Indeed there is good reason to think that many of the trusts have learned not to abuse their power, so that much less need be said.

Yet it is of paramount importance to examine the question. The history of recent years should bear witness to the success or failure of the public policy. Are there any longer trusts? Has the war brought them to stay, or would some other form of control be equally desirable in time of peace? Has the government policy and the machinery for its administration, which largely marked time during the war, been efficiently and actively operated? If so, has it succeeded or failed in eradicating trusts? These questions depend for their answer upon the developments of the last ten years.

As we have seen, the chief forms of trust before 1914 were the holding company and the "Great Corporation." Many of the most promising ones failed to justify themselves in the eyes of their creators during the period 1900-10. Of the remainder, several had been attacked and dissolved by the Courts before 1914, and others were so discouraged thereby as to dissolve voluntarily. Insofar as trusts of open corporate character are concerned, we are interested in those which survived the judicial activity and those which were supposed to have been restored to competition by judicial decree. The Federal Trade Commission reports furnish information with regard to some of these. For example, there seems reason to believe that competition has not been restored in the oil and tobacco industries.

Between 1914 and the present time several long-drawn-out suits have been finally settled. These afford partial evidence of recent developments.

In 1918 the Supreme Court declared that the United Shoe Machinery Company was a patent monopoly, and was therefore lawful, although the dissenting opinion pointed out that it had engaged in unfair competitive practices. In 1920 the Court, by a four to three decision, decided that the United States Steel

Corporation was not acting in undue restraint of trade, and dismissed the case against it. It had acted "in the light of reason." On June 6, 1927, the Court held in similar fashion that the International Harvester Company, although controlling more than half the business of producing and selling agricultural machinery, was not acting in restraint of trade. It had been acting reasonably and in the public interest.

It appears then that there have been few corporate organizations since 1915 suspected of restraining trade, and that most of these have been considered not to be trusts. The Ward Food Products Company, incorporated in 1926, is an important exception. It was charged by the government with acting and planning to act in restraint of trade, through the purchase of stock of competing bakeries, and was dissolved by the Circuit Court under a consent decree.

But if the trusts no longer, in most cases, take the form of corporate combination, we cannot conclude that the trust movement has ended. The developments of the last ten years have not been thoroughly analyzed in a single report, but sufficient information is available to support the conclusion that numerous trusts exist in the form of secret agreements or understandings between corporate competitors and in the form of trade association activities. There have been one or two pools, but these are rare.

The few writers on the subject in recent years give evidence indicating that there is reason to believe that in some industries the activities of trade associations have tended to raise prices substantially above a competitive level. As a matter of fact, the Federal government, through the Attorney-General and through the Federal Trade Commission, has prosecuted trade associations with increasing frequency for alleged violations of the Sherman Act. Though the gathering and public dissemination of trade information has been held to be legal, it has been decided that it may not be used, as it frequently has been, as the basis for raising and maintaining prices. Indeed, so long as there are no agreements on prices or on extent of output, trade associations may legally give

information regarding trade conditions which may be of great value, and may thus indirectly affect prices.

A recent study of the three-year period, 1923-26, covers thirty-three cases prosecuted against alleged trusts in the Federal District Courts. Of these, fourteen concerned secret agreements between ostensibly competing corporations, and sixteen concerned trade associations in many important industries. Of the remainder, one was a pool and two concerned trade unions. At the end of the period studied, seventeen cases were pending, two of these on appeal. Of the sixteen decided, fourteen were against the organizations indicted, and two involved dismissal of the charges. It seems evident from this that far from being quiescent, the trust movement is in full progress.

It is noteworthy, however, that the modern trust, due largely perhaps to the vigilance of public machinery of opposition, has resumed an old form under a new name. The prevailing practice favors agreements and understandings or informal coöperation not easy to detect or prove.

It is evident that the history of trusts is a large part of the history of the control of industrial enterprise. In looking back over this brief survey of that development several things stand out. As to the character of the trust movement, we note that it was and is a direct response to certain forces inherent in modern industry, and that if it ought to be controlled, it must be controlled with those forces in mind. The trusts have not at any time been put out of existence, but have taken new form whenever public opposition has made the old form untenable. As to the extent of the movement, it is to be observed that although it has not existed until recently in agriculture, our greatest single industry (and then only in isolated cases), nor in many important manufacturing industries where conditions were unfavorable, it has been and is so prevalent a feature of modern industry as to constitute a serious problem. And equally significant, being not only a part of the development of trusts but also seriously affecting their form, is the long-continued, gradually developing public opposition to trusts, which

has lately shaded off into an attitude of lack of interest on the part of many and a revision of values in the minds of all. This history of trusts must cease with the present day, only to be continued to-morrow. The future development in connection with the public attitude will constitute an interesting and important chapter of the industrial progress of the coming years.

XV

THE PETROLEUM AGE

By Robert G. Stewart

President, Pan-American Petroleum & Transport Co.

PETROLEUM is one of the most ancient industries in the world and during the last few decades, as a result of American enterprise, organization and investment, it has been developed into one of the greatest modern industries.

The use of petroleum undoubtedly predated recorded history. Before the days of Abraham the oriental races used it for lighting, fuel and medicine. Herodotus repeatedly referred to the use of petrolum and its by-products. He described how the River Is which discharges into the Euphrates brought down many lumps of bitumen which were used in the walls of Babylon, and in the Temple of Nebuchadnezzar.

Petroleum from the fields of Baku was utilized by the Persians at least two thousand years ago and the famous burning springs of the temples on the shores of the Caspian Sea were accepted as evidence of the superhuman power of the priestcraft of antiquity.

There can be no doubt that the pitch the Bible tells us was used by Noah in sealing his ark was asphalt. Later it became known as "Jew's Pitch" because it came from the vicinity of Palestine.

The Sicilians carried on a thriving commerce with Egypt and their principal export was asphalt. It was used in the preparation of mummies and the word *mumai* was a synonym for petroleum. Mummies found in the Azores, Peru and some of the Central American countries give unmistakable evidence of treatment similar to that responsible for the preservation

of the bodies of the Egyptians. In fact, much of the terminology used in the industry is borrowed from Persia, Arabia and Egypt.

In the thirteenth century Marco Polo described the oil fields of Georgiana, and many other travelers of medieval times refer to the fields of the East and the Near East.

But, so far as written records show, the commercial use was not great nor general. With the lack of organization, transportation, modern drilling and refining methods, the business was confined, with a few exceptions, to the localities in which the springs were found.

Before Christopher Columbus discovered America, our own Indians used petroleum as a medicine and for illuminating their religious shrines.

Oil springs were discovered in New York and Pennsylvania in the eighteenth century and the white man, emulating the Indian, used it as a medicine for himself and his animals.

In 1753 George Washington acquired oil-bearing lands in western Pennsylvania, recognized their potential value, and wrote in his will:

> "This tract was taken by Gen. Lewis and myself on account of the bituminous spring which it contains, of so inflammable a nature as to burn as freely as spirits and is as nearly difficult to extinguish."

In the first half of the nineteenth century a few small refineries were operated in the vicinity of Pittsburgh. But it was not until 1859, when Col. Edwin M. Drake drilled the first well in history near Titusville, Pennsylvania, that petroleum was produced in profitable commercial quantities. He accelerated nature's processes to such an extent that men everywhere began to drill for oil, with the result that the consequent overproduction caused the price to fall from almost $20.00 to a few cents a barrel.

During these years there was the wildest speculation and overproduction and chaos. Pipe lines had not been laid and tank cars had not been built. The methods of transportation and refining were extremely crude and limited. In fact, the

country was not prepared to use the crude product in the quantities taken out of the ground immediately after drilling became general.

To-day, after a span of three-quarters of a century, the petroleum industry represents an investment of $11,000,000,000. With the possible exception of agriculture there is no other industry in America of such important interest to the average citizen. Wells in twenty states are producing 70.13 per cent. of the world's production, or approximately 2,500,000 barrels daily.

When a steady quantity production was assured as a result of successful drilling operations, John D. Rockefeller and his associates entered the field and organized the refining and transportation departments of the industry. Just as Colonel Drake must be credited with having laid the foundation for the tremendous production we have to-day, Mr. Rockefeller must be credited with having organized the refining and distributing system.

Even one intimately associated with the industry marvels that the products of petroleum can be sold profitably at prices less than the cost of mineral water.

When one realizes that crude petroleum must be produced from wells drilled to a depth of, in many instances, a mile or more, transported from the well to the refinery, a distance of, in many cases, more than a thousand miles, then refined into its many products and finally in its marketable form shipped by rail to bulk storage plants from where it is delivered to the gasoline pump or service station and finally put into the gasoline tank of the automobile at an average price of less than twenty cents a gallon, one gets a slight comprehension at least of efficient organization, the foundation of which was laid by Mr. Rockefeller. There is nothing in the world to compare to that system. Mr. Rockefeller did more than organize the petroleum industry. The example of his genius has inspired the builders of our entire economic structure as it stands to-day.

With the single exception of the art of printing, our world to-day owes more to petroleum and its by-products than to any other industry developed by man. And the world recognizes

that to Americans must be granted the credit for this tremendous development.

The first change in our social and economic age by the use of petroleum was the lighting of streets. In medieval times the dark street was the rendezvous for the bandit, the robber, the murderer. Gangs organized freely under cover of darkness in the streets of the middle ages to plan their forays. The history of any great city of Europe is replete with stories of the freedom with which factions terrorized the people.

The corner lamp-post was one of the first signs of the civilization we now know. Then came the thoroughly lighted cities and finally the Great White Way. All of these improvements may be traced to petroleum.

Fifty years ago the great business impetus following the termination of the Civil War resulted in the construction of innumerable factories—in a country theretofore largely devoted to agriculture—and petroleum made possible the lubrication of the power element ushering in the period of greatest prosperity known in any country in the history of the world.

In the early days of the American petroleum industry, gasoline represented a fraction of the product of petroleum which, because of its high volitity, was an undesirable product. The supply exceeded the demand. Refiners, anxious to get rid of the then dangerous liquid, have even been prosecuted for dumping it into streams near their refineries.

Then came the internal combustion engine, and the result was the automobile. Some one discovered that by hitching a gasoline engine to a buggy, he had a "horseless" carriage. At the turn of the present century they were curiosities. To-day there are 24,000,000 of them on the streets and roads of this country alone. America is on wheels and the rest of the world has fallen behind only because their economic conditions are such that they cannot afford to follow our lead.

The results of the general use of automobiles have become to us so commonplace that they go unnoticed. It has broken down many social barriers and has made the resident of the city and the farmer neighbors and therefore friends. It has removed the isolation that for centuries has surrounded the

farmer's life, and has given him the opportunity of social relations that he could not have dreamed of twenty years ago.

It has made it possible to centralize and therefore improve the "little red" houses and through the economies occasioned thereby to improve our public school system in the rural districts to marked degree.

It has given his brother of the city an opportunity to quit his unnatural environment and enjoy the country.

In scarcely more than a decade bus lines have been established in virtually every part of the country. Many of them tap sections which were inaccessible because of the absence of any rail facilities. There is to-day scarcely a county in the country that cannot be reached by a bus, whether it be of the de luxe or the jitney type. Express and freight services have been established in many sections where the gasoline-driven truck supplies communities with commodities which they could not have hoped to receive a few years ago. By the same means of transportation the mails to-day are delivered hours and in some cases days ahead of their former schedules.

Many of the political disturbances that have scarred nations have been the direct result of jealousy of the rural population for the cities. That can not happen when they know each other and therefore understand each other. The gasoline-driven car is rapidly making the necessary introduction.

It supplies more than half of the 800,000,000 mechanical horsepower used in America and has made possible the speeding up of production in this country so that the individual American produces many times more than the national of any other land and he receives his share of that production to the end that he enjoys more of the good things of this world than his foreign brothers.

The navies of the world are dependent upon petroleum and each year more and more merchant vessels are equipped with oil burners. It is cheaper, cleaner and requires less crew than coal. The seven seas are dotted with American oil stations and the same is true of virtually every land from the African veldt to Alaska; from Punta Arenas to Petrograd, the

great American companies have stretched their organizations and planted their omnipresent signs of progress.

To tell the full story of the benefits that have arisen from petroleum would be to describe in detail the history of our times and the greatest economic revolution the world has ever seen.

It took a hundred years and an investment of $20,000,000,000 to build America's railroad systems. Considering the fact that this was a young country, the achievement was remarkable. It was no more remarkable, however, than the network of roads that have been constructed in every state of the United States during the last fifteen years. Many thousands of miles of these roads are built in whole or in part of the asphalt which comes from petroleum and the tax which is collected from gasoline helps pay for them.

Something in excess of $1,000,000,000 a year is being expended on these roads and a large proportion of that money is derived from the tax on gasoline. Every state in the Union, except New York and Massachusetts, collects a tax on this product of petroleum.

The development of the industry from every standpoint during the last twenty years is almost unbelievable.

From 1900 to 1925 it was multiplied 11.8 times. During the same period pig iron, in the production of which the United States leads the world, multiplied 2.67 times; bituminous coal, 2.4; copper, 2.67; steel, 2.4; lead, 2.4.

It will be seen from these official figures that while those five leading basic industries which America formerly depended upon for its prosperity grew at normal paces and kept astride of the demands of the country, the increase in the petroleum industry was approximately as great as all of them combined. There is no other chapter in the world's history of economic development that compares with this record. It is a tribute to American vision, enterprise and courage.

This great result would never have been accomplished without the unlimited expenditure of money, energy and intelligence, and the most exacting demands on science.

Twenty years ago there were relatively few by-products from petroleum—to-day there are more than a thousand. Millions and millions are spent annually by the great companies in research work, whereby new by-products are developed and perfected with the consequent increase in demand and the steady enlargement of the business. The public cannot realize the extent to which various corporations have employed scientific methods to supply it with new and valuable articles of commerce which it accepts in the more or less matter of fact way as casual business products.

In 1906, Mr. A. C. Bedford, chairman of the Board of the Standard Oil Company of New Jersey, estimated that approximately $750,000,000 was invested in the entire industry in this country. Five years later—in 1911—the investment was placed at $2,000,000,000. The present investment is reckoned at more than five times that amount.

The Bureau of Mines statistics in 1904 credited the Standard Oil Company group with control of 84 per cent. of the refineries. In 1918—seven years after the Standard Oil Company was dissolved by the United States Supreme Court—the same authority estimated that the companies formerly comprising the Standard Oil Company controlled approximately 42 per cent., and the last available figures show that this estimate has been cut to 30 per cent.

This must not be interpreted to mean that the business of these great companies has fallen off; quite the contrary. These companies have grown and more than kept pace with the phenomenal development of the industry.

It simply means that billions of new capital have been invested in the various branches of the petroleum industry during these years and men and women everywhere have been attracted to invest their savings upon the belief that the business represented an attractive return on capital invested.

It is now estimated that there are approximately 1,500,000 shareholders in the various petroleum companies. Assuming that these figures are correct, it will be seen that the average individual stockholder's investment represents less than $100.

The business has forged ahead so rapidly that it is impossible

to present a definite estimate of the number of employees engaged in it. It is probable, however, that 1,250,000 is approximately correct—this includes the thousands of gasoline station employees scattered throughout the country.

When we add up the number of automobile users, the stockholders and the employees, we begin to realize that virtually the entire adult population in the United States has a very direct interest in the welfare of the petroleum industry.

Oil is drilled in twenty states and in Alaska and is refined in thirty states. The problem of transporting the crude oil from the fields, of refining it into a thousand products and of delivering those products to the public ready for use, has been solved by the creation of systems and organizations which exist in no other industry.

Approximately 2,500,000 barrels of oil are being taken from the ground daily. It would require 10,000 tank cars loaded each day to move this quantity. Of course, such a thing is inconceivable. The American transportation system would be stalled. Despite the fact that 150,000 cars owned by the industry are required to move the liquid by-products and thousands of other cars to transport the non-liquid from day to day, the bulk of the crude oil is moved by the industry's own transportation system consisting of 90,000 miles of pipe lines and fleets of tankers which in the aggregate represent the greatest tonnage under the American flag.

These pipe line systems stretch from the producing fields to the Gulf of Mexico, to the Great Lakes and to the Eastern seaboard. They are operated with all the precision of railroads. They consist of trunk lines and feeders, terminals, and pumping stations. At intervals there are pumping stations which drive the liquid fluid towards its destination, while thousands of employees supervise the system with meticulous care.

More than one-sixth of all the manufactured products moved by American freight cars is refined petroleum and its products and this movement is as great as half the freight movement in France.

In 1926, 1,262 oil tankers carrying more than 7,000,000

tons of cargo passed through the Panama Canal and paid $6,447,399.40 in tolls—more than 25 per cent. of all tolls paid. When the Canal was built no one dreamed of such a tonnage. Petroleum tolls account in large part for the fact that the Canal is the best paying investment the American government ever constructed.

It will thus be seen that the transportation system of the petroleum industry is a great business in itself. It was built by private capital without subsidy or assistance of any sort from the federal government or any state and, of course, represents a tremendous investment. Without such a system America could never have attained its unrivaled position in the industry.

There were in the United States last year 465 refineries with a daily capacity of approximately 3,000,000 barrels of crude oil. They vary greatly in size and capacity. Some of them are located close to the producing fields—others hundreds of miles away. California refineries are capable of treating 841,000 barrels of crude petroleum daily; Texas is second with 577,000; Oklahoma third with 257,000; New Jersey fourth with 251,000; Louisiana fifth with 207,000; Pennsylvania sixth with 184,000.

Crude petroleum is a composite of many potentially valuable commercial products all of which vaporize at different temperatures. The method of deriving these products from crude petroleum is that of distillation. When the most volatile vapors such as gasoline and naphtha fractions are given off they are condensed into liquid form, then as the temperature is increased kerosene fractions vaporize and the heavier fractions become lubricants, paraffine, asphalt and other products.

This very simple, non-technical statement represents the elements of the process. It does not touch upon the tremendous amount of effort and detail required to bring about these results.

Until a few years ago a relatively small amount of gasoline was derived from crude petroleum but the perfection of the "cracking" process has made a very great change in the quantity of the various refined products which come from the

refinery and, in 1926, approximately 35 per cent. of all petroleum was converted into gasoline.

Laboratories retaining the best qualified scientists are constantly employed in improving the processes that have been developed during the last few decades. Wonders have been accomplished since the days when the original refineries processed the crude petroleum and it is but fair to assume that we have not yet reached the peak of perfection. Chemists and physicists are spending their lives in segregating, analyzing and synthesizing deposits in the crude petroleum, while engineers are constantly striving for improvements in the machinery used in the processes.

In addition to the tremendous improvements that have been made in the refining process, the geologist, prospector, and driller have had their tasks materially lightened by science.

The methods of drilling and machinery in use to-day show a vast improvement over the methods and equipment employed by Colonel Drake and his associates, while such instruments as the seismograph and the torsion balance which help locate the sub-surface structures have limited the element of chance involved in the location of pools.

In addition to the experimental, scientific and standardization work done by the various companies, the American Petroleum Institute, a voluntary organization of producers and refiners, has been of great assistance to the industry generally. Among other accomplishments it has compiled many valuable statistics and has helped standardize operating methods and machinery specifications.

While much has been written and much has been said of the desirability of America building up a foreign trade commensurate with her potentialities, the petroleum industry has gone ahead and done its part by extending its business to virtually every quarter of the globe and to-day has the most far flung trade under the American flag.

In manufactured articles exported petroleum now leads all others in America. In 1925 it exported $421,288,000 worth of products and its closest competitor was the automobile and accessory industry with $303,106,000. Agricultural machin-

ery, iron and steel plates, which formerly led our export trade, shipped abroad $162,588,000 worth of materials.

The oil industry as a whole has never earned a profit commensurate with the amount of capital invested in the business and the risks involved. In only a few notable instances have oil companies paid to their stockholders anything like the return that has been paid by other industrial companies. Last year, one gigantic corporation engaged in a business which, without the aid of the petroleum industry could not exist, earned as net profit nearly 70 per cent. of the capital invested in the company. If any one of the oil companies had had net earnings even approaching this percentage, an investigation would have been demanded by the public on the part of Congress.

The facts are that the oil business has been a political football and the industry has suffered as a consequence. To-day the executive heads of oil companies fully appreciate their responsibilities to the public and their earnest desire is to sell the products manufactured by their companies at the lowest possible price, consistent with a fair return on the money invested by their stockholders.

Because of the magnitude of the industry and the number of companies engaged in it, it frequently suffers shocks within itself due to the failure of some of its members to respect the ordinary economic laws of supply and demand.

Just at present the industry is suffering from overproduction. The inevitable result of this condition will be that prices will be driven to the point where profits have vanished. It must be manifest to any one that if this condition continues indefinitely that only those companies with strong reserves can stand the pressure.

When the Great War ended we appeared to be facing a period of stability. Official and unofficial reports indicated that the United States would actually face a shortage within a few years if it continued to squander this natural resource while British oil companies with the assistance of Parliament and the government was carefully harvesting its supplies and reaching to all quarters of the globe to gain control of new

fields. The warnings availed nothing. They appear to have had the effect of encouraging people to seek out new fields in the hope of reaping fabulous profits with the result that the industry is again on the verge of delirium tremens.

There is much food for thought in the following excerpts taken from a recent address made by Mr. E. W. Clark, president of the American Petroleum Institute:

"I do not believe it is too much to hope that a time will come when an industry like ours, confronting the peculiar difficulties that we now face, will be able to lay its troubles frankly and fully, and without fear of unwarranted regulation, before appropriate governmental agencies, and secure measures calculated alike to help us and to promote the true public interest. . . .

"Permit me a moment to suggest that the present critical situation in our history is not one to be considered merely in terms of Seminole, Earlsboro, Sprindletop, Panhandle, or any other momentarily flush area. I submit that we need at this time to take a world view, to think in terms of a decade or a generation, and not of a few months or a year.

"Less than twenty years ago Russia produced more petroleum in a year than the United States. With the epoch of turbulence and revolution, Russia sank to unimportance, while the United States rose to dominance. But we know Russia possesses enormous oil resources. We know that the present Russian Government hopes to turn these petroleum resources into financial support for its desperately weakened economic establishment. We may be sure that before many years Russia will somehow become once more a first-class power in petroleum.

"Then glance to the south of us, and just over the horizon of the Caribbean we see Venezuela, with a potential production as great as was that of the United States only a few years ago. We recognize the assured possibilities of Colombia. On the other side of the world, in the great Persian-Mesopotamian area of the Middle East, we find still another factor of potential and enormous competition.

"We know that since the war more of governmental and industrial energy and effort has been devoted to seeking out the world's resources of petroleum than to any other field of industrial enterprise. And we may not close our eyes to the fact that this search has so far succeeded as to bring the world's petroleum industries

face to face with conditions which certainly dwarf the significance of a few local and temporary phenomena of overproduction here in the United States.

"This is a situation in which we may well invoke the serious thought and earnest coöperation of both political and industrial statesmanship. It does not concern merely a single American industry; it has vitally to do with every power-making, power-using, power-dependent interest in this twentieth century world. It not only deserves to be recognized as of these gigantic proportions, but it demands to be considered and dealt with in the light of such a view as I am here roughly sketching for you.

"If ever there was a world-wide industrial situation that merited, indeed required, to be dealt with in the broadest and most understanding fashion, it confronts us to-day. We need, and we are entitled to, the support and assistance of our government in visualizing and dealing with this world condition. For one, I believe there is vision enough, and liberality enough, among our leaders of national policy and industrial programs, to initiate measures adequate to cope with such a situation."

The Conservation Board appointed by President Coolidge has done some excellent work so far in compiling statistics and in attempting to rivet the attention of the public and Congress upon the serious situation confronting the industry. Its reports indicate that there is available in this country 4,500,000,000 barrels, which represents about 50 per cent. of the total amount already drilled in this country. No estimate of the available supply can be infallible. New fields have been discovered from time to time which discount estimates made by our best informed authorities. However, if that estimate is correct, it means that at our present rate of consumption the country's supply will last less than twenty years.

It would be extremely futile to attempt to forecast the future of the petroleum industry in the United States. It is beyond reason to assume, however, that the present waste and overproduction can continue indefinitely. The day of reckoning will come. We may eventually be forced to extract it from shale or coal. If the country should ever be compelled to resort to that expensive source of supply, the price may be very, very great. Gasoline will not then be the cheapest liquid

to be purchased in America—far from it. Or, we may become temporarily at least dependent upon foreign resources and we may rest assured a very heavy toll will be paid when we are compelled to resort to foreign-owned and controlled supplies. The rubber industry will not soon forget the experience it had two years ago when it found itself short of raw products and had to make immediate purchases from British interests.

The Conservation Board has urged American companies to invest in the foreign fields to a large extent, in order that America may have the benefit of such supplies while conserving her own. Some American companies have gone into foreign fields on a large scale. They have invested hundreds of millions of dollars abroad. But sometimes their investments have been jeopardized, if not destroyed, by alien legislation and regulations. They have become very apprehensive of making further investments in such countries, until they are certain that our government will follow a permanent and wise foreign policy which will protect them in all their rights legally acquired.

It may not be amiss in closing to quote the estimate of America's petroleum industry written by a distinguished Englishman. J. D. Henry, in his history of the industry, wrote:

"This volume is an Englishman's tribute to the engineering skill and resource and bold financial enterprise of the world's most splendid race of oil men—those who have built up the American part of the industry. To-day they and their country are absolutely supreme in oil."

XVI

RESEARCH, SCIENCE AND INVENTION

By Maurice Holland

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THE most striking feature of the world's history during the past hundred years is the extraordinary acquisition of man's knowledge of nature, the deepening of his perception into his own physical, intellectual and spiritual characters and their correlations and the recognition of the tendencies of environment of his future life.

The close of this century shows no signs of an abatement either in the rate of an extension of knowledge or in the significance of successive discoveries.

Industrially, it seems to me, we are approaching the end of the era of mechanical efficiency; automatic machinery has been developed; power application expanded; standardization inaugurated; management engineering and efficiency systems installed and, in short, all the devices of science, applied or engineering, have been employed in the evolution of modern industry.

We are in the first flush of the dawn of the era of science in industry, of a day which is heralded by the vanguard of industrial research laboratories.

Industrial research is a comparatively new tool of industry in America. The first industrial research laboratory was established about forty years ago in the experimental laboratory of the elder Du Pont on Brandywine Creek, in Wilmington, Delaware. Not until the pressure of emergency of the World War demanded the scientific solution of technical problems, a de-

mand which brought into being the National Research Council, was the importance and value of industrial research fully appreciated and applied.

One of the innumerable lessons learned from the political, social and industrial upheaval was the great value of industrial research as a tool in peace-time operation of industry. President Wilson, realizing its importance, promulgated an Executive Order making the National Research Council a permanent peace-time organization, a recognized national instrument to stimulate, encourage and promote research in the industries of America.

What, then, is this thing "Research"?

Defined by the dictionary it is "a systematic investigation of some phenomenon or series of phenomena by the experimental method to discover facts or to coördinate them as laws."

Expressed in less erudite terms research, in my opinion, is a manifestation of that eternal quest of the unknown, the instinctively urged questioning born of curiosity, which has been the impelling motive of human progress through the ages. In short, modern research is accelerated experience.

Modern research may be classed into two main divisions; the first "pure science,"—"academic" or "abstract" research; the second "applied,"—"technical" or "industrial" research. The distinction is one of motive. Pure science research is fundamental; applied research is consequential. The one reveals the forces of nature; the other controls them. The one is the foundation; the other the superstructure.

I have likened modern industry, in terms of research, to a towering skyscraper, the foundations securely anchored in the bedrock of "pure science," the framework of steel girders, strong flexible sinews of "applied science" or "industrial research" and the stones and mortar the solid practical knowledge of experience—the technology of industry.

To say that industrial research is the method of scientific investigation applied to the problems of industry, only partly tells the story. Standardization, testing, material control and process development are intimately interwoven with specific things in industry; they represent science applied or engineer-

ing. Pure science research on the contrary has for its objective the discovery of facts and principles.

Industrial plants have had experimental and testing laboratories prior to the dawn of the industrial research idea and some work was carried on in them that now would be termed industrial research. Considerable experimental work was done in the course of manufacture and the utilization of manufactured products which was essentially of a research nature, but the development of the industrial research laboratory, as such, has really taken place within the last thirty to forty years.

To-day it is one of the basic factors in economic and industrial progress. The results of industrial research is the scientists' answer to the question of industry, "Why?"

The extent to which research has developed as a recognized and valued aid to industry in about forty years is indicated by these statistical data.

We are spending approximately $200,000,000 a year for industrial research in the United States. The Federal Government, with its many scientific and technical bureaus and research agencies attached to practically every department, is spending one-third of this amount while industry is matching dollars, two to one, for the Government's expenditure.

A recent survey in research indicated that the Federal Government was engaged in five hundred and fifty-three separate coöperative projects, three hundred and sixty of which were research, involving altogether eleven hundred coöperative undertakings. The Federal agencies engaged in research include some twenty-three bureaus.

In the survey made by the National Research Council in 1921 and published in the Bulletin Series of that organization, five hundred and seventy-eight industrial research laboratories are listed, exclusive of those attached to the Government's bureaus and the universities. Very recently a new survey has been completed and in the most recent bulletin of the National Research Council one thousand industrial research laboratories, their facilities, personnel and equipment are listed. Nearly 100 per cent. increase in the number of research organizations in six years!

Approximately thirty thousand research workers are employed in the applied science or industrial research laboratories of the country; approximately $15,000,000 is being spent by the trade associations reporting their annual appropriations. The technical colleges and universities last year expended approximately $1,250,000 for industrial research. In general the two most potent forces in the stimulation of research have been the universities and the Federal Government.

A retrospect of the industrial progress of the last hundred years reveals research as the prime mover of industry and discloses its practical effectiveness in reducing to the minimum the period represented by time elapsed from the discovery of a principle in science to mass production.

There is a more than twice told anecdote whose significance strikes harder now than when the incident occurred because the faith of the man of science has been so overwhelmingly justified. Michael Faraday was showing a new experiment in electricity to a member of the British Government. The official slightingly said, "Very curious, but of what use is it?" "By and by, my lord," retorted Faraday, "you may tax it."

This historical rejoinder was uttered nearly a hundred years ago and that Faraday was a true prophet is strikingly shown by the common-place fact that in 1925 one of the largest of our electrical manufacturing concerns paid an income tax of $7,250,000.

Research pertinently inquires, "What factors are responsible for this 'time lag' of nearly a hundred years from Faraday's discovery in pure science research to mass production in the industry?"

How are the milestones in progress marked? They are marked definitely. The successive stages in the development may be designated thus:

First, discovery in pure science research.
Second, applied science.
Third, invention.
Fourth, industrial research.
Fifth, industrial application.
Sixth, standardization.

Seventh, mass production.

This sequence I have named is the "cycle of research." It is not measured in volume of production or dollar dividends, but in terms of time. The speeding up of the period of the cycle, the reduction to the minimum of the "time lag," is the criterion of the effectiveness of scientific research as an industrial aid.

An outline of the history of any of the important industries will determine to what extent it conforms to the pattern of the research cycle. The "time lag" in each successive stage is emphasized in this chronological outline of the development of the electrical industry.

The first stage in the cycle, discovery in pure science research, is represented by the discovery of current electricity by Volta in 1779. Working in "applied science," Sturgeon utilized Volta's observation and constructed the first electromagnet in 1825. Entering the period of "invention," Faraday, based on his investigations in pure science, constructed in 1831 the first dynamo which was destined to "electrify," figuratively and literally, the world.

The period of "industrial research" is associated with the theoretical work of the physicists Gauss, Weber, Rowland and Hopkinson. "Engineering development" is linked with the name of Siemens and the products of the combined labors, theoretical and practical, with the shunt wound, the gramme and drum armatures, as well as the multi-polar machines, while it remained for Edison to make the "industrial application" by establishing the first central station in 1882, at Pearl Street, New York.

With the dawn of the era of industrial research as an accepted industrial tool, there entered in 1890 a new generation of engineers, well versed in physics and mathematics, who mastered the use of alternating currents and to whom belong the credit for the rapid development of transformers, synchronous and induction motors and the huge alternators of the present day. The first alternating current line operated at two thousand volts. Increases in transmission voltage have gone up at the rate of nine thousand volts a year.

The electrical industry of to-day, with a book value of $25,000,000,000 and a generating capacity of twenty million horsepower goes back over the path of progress to the single plant in Pearl Street, New York, forty-five years ago and every step of the way in the development of the electrical industry in the United States has been paved by research.

The electrical is representative of those comparatively young industries which have taken full advantage of research. The three largest concerns in this industry—the General Electric Company, the Westinghouse Electric and Manufacturing Company and the American Telephone and Telegraph Company—are together spending about one-fifth of the total amount appropriated for industrial research in the United States.

The experience of our division of the National Research Council in promoting research in specific industries has demonstrated the truth of the statement that, paradoxical as it may seem, it has been the older industries, such as textile, fisheries, leather, iron and steel, which have been the last to recognize the importance and value of research work.

The spinning and weaving of textile fabrics is one of the original arts—its primitive times go back into the Stone Age. The tools used and the methods generally followed only one hundred and fifty to two hundred years ago had changed but little since the days of King Tut. Up to 1730 all yarn was spun by hand from slivers and rovings. In 1738 a new method of spinning with the aid of rollers was introduced in England and about fifty years later the first mill in the United States was built at Pawtucket, Rhode Island, with its machinery embodying the improvements which had been effected in England.

During the next hundred years American inventors and artisans by improving mechanisms and processes brought the textile industry up to an important place in American manufacturing. In 1895 various mills throughout the country adopted the Northrop loom which revolutionized weaving. Thus far the development of this industry might be classified as an art, rather than an industry, as judged by modern standards.

The textile industry, permeated with tradition and trade

prejudice, based on a technology handed down from generation to generation, from father to son, as it were, at last succumbed to the research idea introduced within the last twenty-five years. A group of textile manufacturers in New England now support a coöperative research organization known as the Cotton Research Company which, in its comparatively short period of operation, has conclusively proved the value of research and the adaptability of its universal application to all types of industry.

The first director of research in one of the largest private laboratories was a physicist. To-day this association is supported by 95 per cent. of the producing industry, employs eighty-seven scientists, including specialists in every field of science basic to the industry; botanists who study the various species of cotton plants, physicists who investigate the physical properties of the fiber, chemists who analyze the constituent elements, mechanical engineers who apply the scientific principles to the manufacturing processes, and finally industrialists who are responsible for the application of the results of research to full-scale production.

An interesting and suggestive synchronism marked the year 1895 when the last word was written in textile history with the introduction of the Northrop loom, coincident with the birth of an industry which, within the time period that measures the span of a single human generation, has come to take first place in importance and size of all contemporary industries—the automobile. Not since the first invention of man, whatever it might have been in prehistoric time, has any human product attained such preëminence in industry in so few years as the automobile.

It is quite safe to venture the assertion that no basic patent, granted by the United States, has so profoundly influenced the social and economic life of so many people in so short a time as the Selden patent of 1895, which covered the principle of using an explosion engine in a road vehicle.

In a little over thirty years the automobile has been pushed by technical development and research to the front rank of the big parade of modern industry. The honor of being the first

to make a successful gasoline automobile belongs to Charles B. Duryea. In 1900 R. E. Olds made the first type gasoline automobile and Henry Ford produced his first machine in 1903.

The motor-car industry not only has taken full advantage of the possibilities of its own research organizations but its spectacular expansion has given impetus to other classes of industrial research such as rubber, the metals, petroleum products, leather, synthetic fabrics and compounds, road materials and, also, research in advertising and salesmanship.

The research laboratories of the General Motors' group, and those of Studebaker, Ford, Packard, Dodge and other automobile concerns are models of their kind. "I can tell the kind of a car it is by one look at the radiator," is a frequently heard curb-stone observation. "I can tell the kind of a car any company in the business will have in two to three years by one look at its research laboratory to-day," would be a commonplace assertion of a scientific member of the research staff of a motor-car plant.

Electric illumination, radio, electrochemical and the telephone are four industries which have developed from their basic inventions to important places in our present industrial organization in a period of less than fifty years. In each there is striking evidence of the inter-relation of the "cycle of research" with the various stages in the development of its industry.

Reviewing the growth of the electrical illumination industry in briefest outline brings to view the various steps in rapid succession, including the discovery of the principle of heating platinum wire to incandescence by Sir Humphry Davy in 1800; the experimental work on a carbon conductor in an evacuated glass bulb by the American, Starr, in 1841; the first successful incandescent lamp developed simultaneously by Edison and Swan in 1878; the products in industrial research, the tantalum lamp in 1902 and the tungsten drawn wire in 1906, which now has been adopted as the universal form; mass production is reflected in the figure $90,000,000 paid for incandescent lamps in 1924. No stronger evidence of the benefits of research to

the general public can be presented than the signal fact that the cost of a given amount of light to-day is about 5 per cent. of what it was in 1880.

Radio, that modern miracle worker, was waved into the world on the wand of magic a little more than fifty years ago. Its parentage was unquestionably scientific since it was created out of the stuff that science is made of—the involved mathematical formulas of Maxwell, an English physicist. In 1890 Hertz demonstrated the truth of Maxwell's theory and five years later Marconi gave the invention to the world in the first actual wireless telegraph.

To-day one can 'phone to London from New York at twenty-five dollars a minute and last year over half a billion dollars' worth of radio equipment was made and sold to the general public.

The telephone, although by certain standards not classified as an industry, is the classic illustration of research as an industry builder and the servant of man. Three points are to be emphasized in tracing the telephone's development: First, that in the short space of but half a century its growth has expanded from a single telephone to a concern which is rated as the largest individual corporation in the world. Second, that the research laboratories of the American Telephone and Telegraph Company, spending approximately $13,000,000 a year for research, has been the largest single factor in this development. Third, that its inception and subsequent growth was paralleled with the development of industrial research in the United States.

When one thinks of big jobs—a great engineering feat such as the Panama Canal comes to mind. Building it cost a little more than $300,000,000. Enlarging the telephone system of New York, New Jersey and part of Connecticut called for an investment of over $500,000,000 since the first of January of 1920.

Fifty-one years ago the world's entire telephone plant could be held in the hand of one man—the instrument Bell invented. Something like ten million calls are now made each day in New York and its environs. To-day there are more than seventeen

million instruments, twenty-one thousand central stations, three hundred and fifty thousand employees, twenty-five million miles of wire and a total plant investment of $2,000,000,000 in the United States alone.

Milestones along the Royal Road of Research which mark this phenomenal growth are inscribed in this fashion:

By increasing the number of pairs of wire carried in a telephone cable from fifty in 1880, to fifteen hundred in those in present use, $100,000,000 has been returned to the treasury.

By replacing the tin used in lead cable with antimony, $6,000,000 was saved in ten years.

A new contact metal to replace platinum has paid a dividend exceeding $13,000,000 since 1916.

The phantom circuit system applied to a network of four hundred thousand miles of wire netted the American Telephone and Telegraph Company $80,000,000 in the trade of facts for dollars.

The research laboratory was virtually the birthplace of the electrochemical industry. Wöhler, the German scientist, discovered aluminum in his laboratory just one hundred years ago. About twenty-five years later the "rare" metal was worth $90 a pound. To-day it has become so universally used that every American housewife is familiar with it and its uses are manifold. By 1886 aluminum had fallen in price to $12 a pound and the American Castner process brought the price down to $4 a pound three years later.

Hall, in America, and Hersult, simultaneously in Europe, discovered that cryolite fused readily at a moderate temperature and when so fused dissolved alumina as boiling water dissolves sugar, and to the extent of more than 25 per cent.

The pure science or discovery period represented by Wöhler was followed by the labor of others in applied research which brought the development to the period of invention. In 1895 the manufacture of aluminum was started at Niagara Falls under the Hall patents. In 1911 the market price of the metal was twenty-two cents a pound and the annual production forty million pounds. By 1919 the production had increased to four hundred million pounds—two hundred thousand tons, ten times

the annual amount of 1911. This latter statement indicates industrial application and suggests mass production.

The electrolytic refining of copper is one of the major electrochemical industries. One of the forms in which the metal is most prominently available to-day is electrolytic copper and the extraction of gold and silver electrolytically is assuming important proportions.

The salvaging of wasted material has been developed to a remarkable degree as a result of the incessant questioning of industrial research. An illustration is tin scrap. The recovering of tin from tin cans and other scrap is now carried out electrolytically. About 90 per cent. of tin in scrap is salvaged in form 99 per cent. pure. Electrolytic iron, which is used in considerable amounts in the manufacture of certain types of telephone equipment, also is very pure.

Unmistakable evidence of the successive stages in the research cycle from the discovery in pure science to mass production in industry appear in these hastily sketched outlines of the few selected industries. It is significant that the time lag in these industries has been reduced to something less than fifty years. What is the nature of the factors which have been responsible for this phenomenal growth? The second fundamental principle is the relation of research to specific industries.

This relation is quite definitely governed by five factors which have only to be named to be recognized as constituent parts of the research equation. They are: (1) the rate of growth and development of the industry itself; (2) the inherent technical nature of the industry; (3) the character and number of the technical personnel employed in the industry; (4) the position in foreign trade; (5) the present research facilities available to the industry.

The third fundamental principle in the relation of research to industry is the period of the introduction of research and the accelerated development which follows. This effect has been indicated in the description of several of the younger industries. What happens when research is undertaken in older industries—the iron and steel, for example, one of the oldest in recorded history?

Possibly the oldest piece of iron known was found in the great Egyptian pyramid "Gizeh"—at least six thousand years old. Of the primitive furnaces one type, still used in remote parts, was successfully developed by the Germans in the Middle Ages. It is known as the Catalan furnace because it was first used in Catalonia, Spain.

The first man to melt iron in a blast furnace with coke instead of charcoal was Dudd Dudley, in England, in 1617. Some hundred and twenty-five years later the crucible process of making high-grade steel was introduced and more than another century elapsed before Bessemer's process revolutionized the steel industry.

The period of the introduction of research and the subsequent rapid development of the steel industry began when Professor Sauveur, of Harvard, in 1898, put forward his first iron carbide diagram, showing the eutectoid transformations and their relations to the heat treatment of steel.

In 1900, the development of high-speed steel by Taylor and White was first demonstrated in Paris. Vanadium high-speed steel was introduced in America by Dr. J. A. Mathews, the present research director of one of our largest steel concerns. Others were experimenting with it in Europe but vanadium high-speed steel was first put on the market by an American company.

To indicate the development of the basic processes of steel making, in 1909 only six-tenths of one per cent. of steel was made by the electric process while 4 per cent. was crucible. To-day less than 2 per cent. is crucible. The phenomenal growth of the steel industry is indicated by the fact that the production has risen to seven hundred pounds per capita in 1920 and to one thousand pounds per capita in 1925. The extensive use of vanadium dates back only a few more than a score of years and molybdenum less than half as long.

Research in the steel industry has made possible the automobile and aeroplane, or to put it the other way round the demands of the automobile and aeroplane have produced advances in steel. A Ford car would have cost five times as much as it does now and the Ford plant would have been many

times as large as it is now for the same production had it not been for Taylor and White's investigations into high-speed steel and it could not have been produced at all in its present design had only carbon steels been available. The introduction of vanadium resulted in doubling and trebling the efficiency of the original high-speed steel which followed Taylor and White's research work.

This sketchy outline of the time-honored iron industry shows that the steel industry for hundreds, if not thousands of years, was an art and that within less than fifty years it has felt the influence of research and has experienced a greater development in that period of five decades than all the centuries that went before.

As another example of an industry whose beginnings are lost in antiquity, consider the fisheries, in which present-day methods of operation are fundamentally the same as two thousand years ago, as described in the incident of the Sea of Galilee, in which the fishermen were told to lower their nets for the catch. The importance of fisheries as an industry is indicated by the following data: Of the annual output of the fisheries industry, which is approximately thirteen billion pounds, the United States supplies three billion pounds, valued at $109,000,000 to the fishermen. The annual value in this country of the products is $172,000,000. The industry employs 195,000 persons. Of the 115 industries listed by the United States Department of Commerce fisheries ranks sixty-eighth, and of these same industries less than ten have a higher number of wage-earners than fisheries. The annual product per person has a value of $880—in the motor-vehicle industry this value is over $13,000.

The fisheries industry like others of the older type has had to cope with the traditions and prejudices of an ancient institution. It is loosely organized and made up, for the most part, of small units. It has not participated in the general movement towards coöperative marketing; it has not availed itself of the opportunity to draft a trained personnel. It is quite true that the processes of this industry are not inherently technical but research is necessary to improve methods of capture, manu-

facturing processes and the utilization of waste. The number of technically trained personnel in fisheries is negligible.

The present situation of this industry in respect to its relation to research, a connection of quite recent adoption, is well presented by the opening paragraphs of the 1927 annual report of the United States Commissioner of Fisheries to the Secretary of Commerce. They read thus:

"Perhaps the most noteworthy development of the year has been the growing appreciation of and expressed need for expansion of modern scientific research in the solution of fishery problems. This is shared by men in the fishing industries confronted by the many problems in the taking, merchandising and distribution of fish and fishery products; by State and other officials interested in determining the condition and trend of each fishery and the need for and character of regulations necessary for the husbanding and wise use of our fishery resources; by Federal, State and private agencies confronted with problems of large-scale fish propagation; the prevention of losses by fish diseases and the development of the science of aquiculture; and by the thousands of organizations and individuals interested in having good fishing and enjoying the use of lakes and streams for recreational pursuits. It is believed that the Bureau's present program of practical research and applied science is accomplishing much in inspiring confidence and dependence on modern science for the solution of problems in fish culture, fishery administration and technology. This also applies to the important duty of regulating and conserving the highly valuable fisheries in Alaska.

"The concern felt for the future of such fisheries as those for shad, sturgeon, whitefishes and lobsters, and the appreciation of the value of scientific research as a basis for wise administration of fishing resources, has caused demands to be made wholly beyond the scope of the scientific staff to cope with; and the same is true of demands for assistance from the Bureau's technological staff in solving the problems of commercial fishermen."

Having briefly traced the historical development of five industries which have reduced the time lag from basic invention

to full-scale application in less than half a century, and have set up for comparison three industries which had their beginnings in earliest recorded history, what conclusions can be drawn?

First, all five industries—the radio, electrochemical, electrical illumination, telephone and motor-car—are technical in nature, employing technical personnel, have had a rapid development and growth and productive processes which are dependent upon technical knowledge rather than skill. They then include four of the factors which have been cited which govern the relation of research to specific industries.

Second, all five closely follow the successive stages in the research cycle.

Third, at least two—radio and electrochemical—were virtually created by research. Two of these industries—the automobile and electrical—have taken first and second places, respectively, in importance and size among all industries in less than fifty years, certainly a minimum in time lag even in these days of high-speed, automatic machinery and mass production.

The telephone rightly deserves individual recognition even though it may not be precisely classed as an industry. Emerging as an invention from Bell's experiments, its individual development and application has produced the largest single industrial concern in this world. This preëminence has been attained almost wholly through results of research. The assurance of its position, based on a technical monopoly, has been maintained by the backing of the largest research organization in existence attached to a private enterprise.

Of the five industries in the first group there remains but one to consider, namely, the electrical illumination, since its development in the major aspects is a parallel to that of the telephone. The initial impetus may properly be credited to Edison's first successful incandescent lamp, but the widespread industrial application in the present universal form dates from the drawn tungsten wire of the pure science research laboratories of the General Electric Company, in which the development of the Mazda lamp, as it is called, was carried through

the complete research cycle under the supervision of the research unit.

Of the two industries—the textile and iron and steel—in the second group, even in the comparison of the bare outline of their development it is apparent that it has taken centuries to accomplish in them what has been done with the aid of research in a few decades in the first group.

The research laboratory has become recognized as an essential, indispensable part of the plant of many manufacturing concerns whose outputs are representative of practically all major industries and their subdivisions. Bulletin No. 60 of the National Research Council contains the names of a thousand or more corporations which maintain research laboratories—a striking indication of the high value which captains of industry have placed upon science as a live, productive asset.

This appraisement of research by the manufacturers is reflected in a recent statement of the National Bank of Commerce of New York which sets forth its analysis of the basic factors in the present era of prosperity in which this significant paragraph occurs: "Not only are we freely utilizing the processes being developed elsewhere, but individual industries and groups of industries are making great expenditures for research of a type to be directly productive, and a few are doing remarkable work in theory."

In the not far distant day forecasting futures by a study of the present trends of research in industries will be reduced by trained observers to the same simple formulas and computations which now govern the transactions in May cotton and December wheat on the New York Exchange. In the "technical or science audit" of an industrial company, barometer charts based on technical, not the commercial, state of industry will appear. The technical audit, as a supplementary safeguard to the protective devices now used in long-term industrial loans, seems to be an inevitable development in banking.

Some of the factors behind the scenes of the balance sheet which play important rôles are the technical state of the art, the plant, the processes and the product. Research facilities, the attitude of the management toward research and technical

advances made in foreign countries which may influence the domestic market, all have a meaning to the eye of a skilled observer which may be translated into the language of dollars and cents—deficits or dividends.

In this age of mass production, big volume, quick turnover, the average American business man wants action! A quick return. His conception of research is that it is something like a mysterious box of black magic, in which you should be able to put a research appropriation in the slot, turn the crank, and dollar dividends would roll out. Compare that picture of the attitude of the American executive with the business judgment and vision which financed the "speculations" of academic-minded Ph.D.'s, and were rewarded with the control of the dye markets of the world by Germany.

The National Research Council, operating under the Congressional charter of the National Academy of Sciences, undertakes the coördination of research work and research agencies in the United States. It enjoys the unqualified approval and has the full coöperation of the United States Government although it is not an official department or bureau of the Federal Government. The popular conception of the Council, however, is that it is a Federal establishment.

The Council is a coöperative organization of scientific men of America. Its membership includes, however, not only scientists and technical men but, also, business men interested in engineering and industry. The Council was organized in 1916 to coördinate the research facilities of the Nation on war problems.

It has the coöperation of the major scientific and technical societies of the United States, its membership being largely composed of appointed representatives of these organizations, representatives of other research bodies, representatives of the Government's scientific bureaus and a limited number of members at large.

In 1918, by an Executive Order of the President of the United States, the Council was reorganized as a permanent body for the promotion of research and with the purposes summarized as follows:

In general, to stimulate research in the mathematical, physical, and biological sciences, and the applications of these sciences to the engineering, agricultural, medical and other useful arts.

To summarize the larger possibilities of science, to formulate comprehensive projects of research and to develop effective means for utilizing the scientific and technical resources of the country.

To promote coöperation in research at home and abroad.

To serve as a means of bringing American and foreign investigators into active coöperation with the scientific and technical services of the War and Navy Departments, and those of the Civil branches of the Government.

To direct the attention of scientific and technical investigators to the importance of military and industrial problems and to aid in the solution of those problems by organizing specific researches.

To gather and collate scientific and technical information at home and abroad in coöperation with governmental and other agencies.

The Executive Order of the President directs the departments of the Government to coöperate with the Council.

While the principal offices of the National Research Council are in the Nation's capital, its Division of Engineering and Industrial Research is located at New York in the center of engineering activities, so as to effect closer coöperation. This division aims to carry out the general purpose of the Council in the field of engineering and industrial research. It seeks to minimize duplication, to concentrate effort, to suggest programs for projects, to encourage individual initiative and to disseminate research information. In general, it seeks to stimulate industrial research.

The United States Bureau of Standards in Washington, which was established by Act of Congress in 1901, is the most important of the scientific and technical establishments of the Federal Government. Its growth during a little more than twenty-five years, from a single building and a modest personnel to its present imposing plant of a score of buildings and

a regular staff membership numbering 850 and an annual expenditure of $2,475,000, is another indication of the wonderful growth attained by industrial research. In addition to the regular staff there are working in the laboratories 63 scientists assigned to the Bureau under its research associate plan and eleven "guest" scientists and technicians, making the personnel total 924.

Most of the Bureau's work is made effective through voluntary coöperation of state and municipal governments, scientific and professional societies, trade associations, manufacturers and individuals who accept the findings of the Bureau and incorporate them into a state law, a municipal ordinance, a dimensional standard, or a standard of quality, performance or practice.

"All such coöperation," states the Director of the Bureau in his 1927 annual report, "is encouraged to promote a better understanding between producer and consumer and between industries, to the end that industries shall be, as far as practicable, self-regulatory. Many national organizations assist the Bureau directly in research, standardization, and simplification, and the Bureau, in turn, coöperates with numerous organizations engaged in similar effort, frequently designating members of the staff to serve on committees.

"The extent of these relationships is shown by the fact that at the present time the Bureau is coöperating with over 200 scientific, technical and industrial organizations. In many cases the work with any one group covers a single project, while on other cases twenty-five projects or more are being handled by practically every division of the Bureau. One of the most effective ways in which the Bureau coöperates with American industries is through its research associate plan. At the close of the year there were 63 of these associates stationed at the Bureau, representing 38 different industries and organizations."

With the rapid growth of industrial research, the rapidly increasing number of industrial research laboratories with their almost unlimited facilities for discovery and fact findings, invention, as it is popularly understood, is losing its primary

status; it has taken its rightful place as one of the stages of the "cycle of research."

The vanishing independent American inventor can be cited as one of the many indications of the profound influence which scientific research is exerting in the every-day activities of the industrial world.

Time was, say before fifty years ago, when the American genius, in the form of the independent inventor, held sway, gripped by ambition and impelled by the questioning urge, revolutionized industries and made economic history. The story of Goodyear and rubber, Edison and the incandescent lamp, and a hundred others, have glorified the American inventor in the past.

But what chance has the independent inventor to-day against the formidable research organization of the Bell Telephone System, where 3,900 people (over half of them scientists, engineers and technicians) are spending $13,000,000 a year to maintain a technical staff to reduce costs, improve service and even eliminate the "Hello" girl with automatic machinery?

What chance has the budding "Westinghouse" to cope with the pure science laboratories of Whitney, the applied science laboratories of Elihu Thompson and the works-control laboratories forming the foundation, the bulwark and the outposts of science underlying the processes, products and increasing the service and sales of a vast organization such as the General Electric Company?

How much opportunity is there for an independent inventor in the field of chemistry in the present day when organized research is an integral part of the manufacturing plants of the "Big Three"—the Du Pont, the General Chemical and the Union Carbide and Carbon Corporation—in the chemical industry?

One American inventor—a hybrid of the pioneer inventor and the later day scientist—Dr. Cottrell, donated royalties derived from one of his great inventions to the support of a foundation known as the "Research Corporation," a non-profit organization, to encourage, assist, develop and market the inventions of and for ambitious young American inventors.

Consult the files of this organization where on an average of 200 inventions are submitted a month and there will be found proof-positive that less than one per cent. pass the requirements for commercial development. The record of the Naval Consulting Board, of which Thomas Edison was chairman during the World War, shows that about one invention in 20,000 had practical possibilities.

Of the million-odd inventions recorded at the United States Patent Office—in the annual grist of that "idea mill"—less than five per cent. of those which reach commercial development and industrial exploitation are the result of independent inventors. The patents granted as the result of the work of industrial research organizations of this country run into the thousands monthly.

Since provision was first made by Congress, in 1790, for giving to inventors the exclusive right to their discoveries, more than 1,690,000 patents have been issued by the United States Patent Office. The patent laws stimulated invention and in the days before automatic machinery, repetitive operations and the development of industrial research eliminated much of the "Jack-of-all-trades" character which once distinguished the American craftsman, skilled artisans and "natural" inventors secured many valuable patents—yet but a small proportion arrived at the successful commercial stage.

The impersonal scrutiny of facts-seeking historians tracing the records back to the "only firsts," has clouded the titles of priority claimed for some of the historic inventors. Invention has not escaped the philosophic treatment of the higher criticism. Almost every one of the so-called "basic" inventions is the subject matter of controversy. The pedestals of a considerable number of hero-inventors have been tilted.

The principal cause of the confusion as regards priority in the historic inventions is that the common understanding does not take into account the fact that a great invention is not the completed product of a single man—it is the resultant of many inventions, the composite of a number of realized ideas merged into a workable whole.

The steamboat is a good illustration. Fulton's "Clermont,"

which took to the waters of the Hudson River in 1807, is the "first" steamboat in the popular American mind, perhaps because Fulton was an American. But the records disclose the disconcerting fact that before Fulton's adventure there were steamboats in England, France, and even in the United States.

Morse, in 1840, was granted a patent on his telegraph instrument—and in this country Morse is the first man to think of a telegraph. But there was a telegraph line in England several years before and the German people claim that one of their scientists invented the telegraph as early as 1809. The steamship, the telegraph, the telephone, the locomotive, the printing press, all the great inventions, can be traced back beyond the times of their popularly acclaimed "inventions," and some of their beginnings go back beyond the births of those who are heralded as their inventors.

Excepting Whitney's cotton gin patent issued in 1794 the patents generally classed as "basic" were granted in this country during the period covered by the centenary under consideration. Some of the outstanding ones are in this list: McCormick, reaper, 1834; Colt, revolver, 1836; Morse, telegraph, 1840; Goodyear, vulcanized rubber, 1844; Howe, sewing machine, 1846; Corliss, valve gear, 1849; McKay, shoe stitcher, 1862; Gatling, machine gun, 1862; Sholes and Glidden, typewriter, 1868; Westinghouse, air brake, 1869; McGaffey, vacuum cleaner, 1869; Hyatt, celluloid, 1870; Goodyear, shoe welt machine, 1871; Robinson, electric train signaling, 1872; Chesebrough, vaseline, 1872; Jamey, automatic train coupler, 1873; Glidden, barbed wire, 1874; Bell, telephone, 1876; Edison, original phonograph, 1878; Beams and Hyatt, reënforced concrete, 1878; Berliner, continuous current transformer, 1878; Brush, arc light, 1879; Edison, carbon filament, 1880; Reece, button-hole machine, 1881; Ritty and Birch, cash register, 1883; Golding, expanded metal, 1884; Brown, blast furnace charger, 1885; Thomson, electric welding, 1886; Telsa, induction motor, 1888; Hall, aluminum process, 1889; Mergenthaler, linotype, 1890; Berliner, transmitter, 1891; Stowger, automatic telephone, 1892; Ives, half-tone process, 1893; Edison, kinetoscope, 1893; Selden, automobile, 1895;

Curtis, steam turbine, 1896; Acheson, carborundum, 1896; Lanston, monotype, 1896; Pupin, long distance telephone, 1900; Taylor and White, high-speed steel, 1901; Gillette, safety razor, 1904; Owen, bottle-making machine, 1904; Fessenden, radio wave production, 1904; De Forest, radio tube detector, 1906; Dumwoody, radio crystal detector, 1906; Wright Brothers, aeroplane, 1906; De Forest, radio grid, 1908; Baekeland, Bakelite, 1909; Hewitt, mercury vapor light, 1912; Coolidge, tungsten filament, 1913; Armstrong, radio regenerative circuit, 1914.

In the United States our prosperity has been largely based on cheap land and superabundant raw materials. To-day our civilization has developed to such complexity that we cannot hope to maintain our position except through the assistance only science can afford. The research laboratory has become the prime mover for the machinery of civilization.

I can think of no more effective way to present a perspective of the value of science to the economic progress of a nation than to quote that eminent philosopher, Huxley, when he truly said,

"I weigh my words when I say that if the Nation can purchase a potential Watts, a Davy or a Faraday, at the cost of a hundred thousand pounds down, he would be dirt cheap at the money."

XVII

INDUSTRIAL CHEMISTRY

By Chas. M. A. Stine, A.M., M.S., Sc.D., Ph.D.
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THE contribution of the chemist to the necessities and comforts of everyday life constitutes the theme of many expositions which are familiar to every intelligent reader of to-day. The brief time in which many of these have been developed and made universally available may be appreciated by recalling how few of these the men of one hundred years ago enjoyed. We doubtless think first of the many contributions of the mechanical and electrical industries, such as the railroad, the telegraph and telephone, and so on. At that time, the electrical industry was entirely a thing of the future, and the application of power in manufacturing and transportation, which produced such a revolution in the mode of living, was just beginning. To these developments, the chemist as well as the engineer has made significant contributions; but, in addition, chemistry is the very basis of such developments as rubber, petroleum, Portland cement, high explosives, synthetic dyes, plastics like celluloid, metals such as aluminum and alloys which at that time were unknown. Chemistry has contributed to agriculture in the solution of problems of primary importance which at that time were not even suspected, and the part which chemistry plays in such vital matters as sanitation and health was undreamed of. The medicines available for the sick were limited in number and frequently nauseous in character. Anesthetics and antiseptics were unknown. Glass was made, but not in the variety nor of the quality known now, and plate glass and optical glasses of the standards of to-day were not known. Clothing was coarser in texture and

drab in color. The ordinary means of artificial lighting were candles. There were no matches. The soap which was used then would find no ready market to-day. The porcelain, china, crockery and glass, which constituted the tableware, were more expensive and less attractive than those of to-day. Even the foods available to the richest man of the time were more limited in variety and far more determined by geographical location and season of the year. Especially in the case of sailors the restricted diet was often the cause of disease. Artificial refrigeration for the wholesale preservation of perishable foods was a thing of the future. The preservation of vegetables, fruits and meats was, to a very large extent, the concern of the housewife, and the wholesale preservation of fruits and vegetables in what we know as tin cans was not in existence. One rode a horse or traveled in a stagecoach all day to get as far as the modern automobile will travel in an hour. It took months to send a message, where now seconds suffice. To discuss a business proposition meant the physical presence in the same room of the interested parties. This might involve hours or days of travel. A few moments at the telephone now suffice. The creature comforts and facilities for recreation and amusement of the modern world are, to a very large extent, the result of the application of science to the problems of life in the last hundred years.

In other words, the chemical industry, as we now recognize it, is itself largely a product of the last century. At the beginning of this time there scarcely existed a chemical industry, in the modern sense of the word, though it may be said that chemical processes of a sort found in the useful arts are as old as man. Chemical industry may be said to have the following characteristics: It produces something which is essentially different from the raw materials employed; the preponderance of the operations involved in the industry involve chemical changes; these operations are under the direction and control of trained chemists; the business itself is directed by men with chemical training or with a chemical outlook. If these criteria are applied, the few small establishments which existed in 1827 scarcely fulfill these requirements. The processes were,

for the most part, not based on any exact scientific knowledge or subjected to chemical control, but were arts handed down from one generation to another.

Considering, however, those industries in which chemical change played a predominant part and which yielded products chemically different from the raw materials employed, the foundation for our present chemical industry, which existed a hundred years ago, consisted of the manufacture of leather, iron, steel, salt, lead, glass, linseed oil, paper, brick, crockery, and porcelain. In the early part of the nineteenth century there had been a marked development of domestic manufactures due to the anti-British feeling which culminated in the War of 1812. Indeed, certain processes had been started very early in the American colonies. As far back as 1608, an unsuccessful attempt had been made in Virginia to manufacture pine tar, potash, and glass. The production of glass, alcoholic beverages, salt, leather, iron and lead from native ores were the industries first started and most widespread in the colonies. The territories of Pennsylvania and Massachusetts included most of these ventures, though the great salt deposits of New York were discovered by the whites as far back as 1654. However, it was not until 1787 that the manufacture of salt was begun. The extraction of natural dye-stuffs and the manufacture of saltpeter, sulphur, gunpowder, paper, and, of course, metallurgical operations and the manufacture of salt were encouraged by the colonial congresses. In 1730, the first large sugar refinery was erected on what is now Wall Street, New York. In 1790, white lead manufacture was begun in Philadelphia, and soon several firms were engaged in this enterprise. The following year anthracite coal was discovered in Pennsylvania. In 1793, the year in which the cotton gin was invented, the first unmistakably chemical industry, the manufacture of sulphuric acid, was begun in Philadelphia by John Harrison, with an output of three hundred carboys per year. In 1802, the manufacture of gunpowder by Eleuthere Irenee duPont was undertaken at Wilmington, Delaware, although powder of an unsatisfactory sort had been made in this country previously. In 1814, John

Harrison, for the first time in this country, used a platinum still for the concentration of sulphuric acid, a very important technical advance, greatly increasing the output and diminishing the cost of this important commodity, the consumption of which, it has been said, may be used as an index of the civilization of a people or a period. In 1816, the distillation of plants, to obtain the essential oils such as peppermint and wintergreen, was begun; and the distillation of coal to give illuminating gas had been started in several of the larger cities. The manufacture of certain medicines and fine chemicals had also been established, as, for example, the production of quinine sulphate, spirits of niter, and so on, by Rosengarten & Sons in Philadelphia, in 1823. In 1828, the year in which the first railroad for a steam locomotive was built in this country, P. B. Smith founded the first domestic varnish factory in New York City.

In 1831, there met in New York a "General Convention of the Friends of Domestic Industry," the purpose of which was to urge on Congress the necessity for protecting American industries from European manufactures by an adequate tariff; and a committee on chemistry drew up the first report ever prepared on the status and the requirements of the American chemical manufacturing industries. This report mentions the manufacture of sulphuric acid and of several other common chemicals and the fact that their prices had steadily dropped since their production began in this country. The manufacture of a high grade Epsom salts had practically excluded the use of Glauber's salt and had led to a considerable export trade in this commodity. Certain pigments such as Prussian blue, chrome yellow, and chrome green were manufactured in considerable quantities. Potash was made from wood ashes. The committee called attention to the "highly interesting fact that nearly all the materials used in chemical establishments are the product of our country." One of the outstanding characteristics of chemical industry is the great increase in the value of the products which is brought about when either relatively cheap or otherwise entirely useless by-products and raw materials are passed through the manufacturing processes

involved in chemical transformations. Clay may be used to manufacture alum, iron ore and pyrites to manufacture iron and steel, sulphuric acid, and dozens of other interesting and important chemicals. A mineral containing magnesia is the source of Epsom salts. The waste products, such as the blood which flows from the slaughter-house, and the bones and refuse portions of the carcasses of animals, are transformed into interesting and highly useful products.

This committee of a bygone day points out that the very air we breathe is made subservient to the needs of chemistry and converted into useful merchandise by combining oxygen with sulphur to form oil of vitriol and other chemicals. In an even more important sense, this has become true in these latter days when the other constituents of the air, such as nitrogen, argon and neon, are of the first importance in the chemical industry. Nitrates, for fertilizers, and ammonia are produced directly from the nitrogen of the air, with the result that the fixation of atmospheric nitrogen by chemical processes has become a matter of basic importance in the sustenance of the human race. This "Convention of the Friends of Domestic Industry" pointed out that chrome yellow, as a common pigment, was even then the result of American industry. "It was originally discovered native in the Uralian Mountains and sold for its weight in gold." The discovery of chromates of iron in considerable quantities near Baltimore, Maryland, has resulted in the working of that locality for chromium compounds for many decades.

The committee referred to the great mineral resources of the country and went on to say, "It would swell this report beyond its proper limits, were your committee to give in detail the history and resources of the manufactures of this country. They are able to enumerate thirty chemical establishments in the United States. The capital invested in these concerns, according to the best estimate that can be made, is $1,158,000. The value of the articles produced may safely be put down at $1,000,000; the number of hands employed at nine hundred."

A side-light is thrown on the industry of that time by a

statement in a succeeding paragraph of this same report in which the committee, by way of illustrating the immense quantity of fuel consumed in some of the laboratories, stated that one establishment in Baltimore required 4,000 cords of wood per annum besides some coal. But it will be seen that then, as now, chemical industry converted materials of little value into objects of utility, and that its net effect was to lower to the consumer the price of the necessities and luxuries of life.

It will enable us more vividly to picture the growth of the chemical industry if, instead of following it year by year, we now jump nearly fifty years and observe what progress was made in that time. In the year 1874, a group of chemists met at Northumberland, Pennsylvania, at the home of Joseph Priestley, the discoverer of the element oxygen, to celebrate the centenary of that discovery. From this meeting grew the American Chemical Society, which was organized in 1876 with a membership of about 200. It may remind us of the growth of the country since then to recall that it was in this year that a detachment of regular United States troops under the command of General George Custer was entirely annihilated by Indians. Telegraphy had then been developed, and railroads crossed the continent.

At the meeting in Northumberland, the status of industrial chemistry was reviewed by J. Lawrence Smith, who was especially well qualified by virtue of his experience and breadth of knowledge. The omissions from his report are no less striking and significant than the accomplishments he records. By that time chemistry was definitely recognized as a profession, though it had but a small following. The basic laws which make chemistry a science had been discovered and enunciated, and by 1860 the *present* chemical notation had been developed. There had, moreover, been many significant developments in the industry.

In 1839, Charles Goodyear discovered his process for vulcanizing rubber and thus founded a new industry. Previous to that time, rubber had been of little value in spite of many efforts to employ it in useful arts. It even derives its name from the fact that its most practical use had been to erase

pencil marks. The prominence of rubber in our life to-day needs no emphasis. Petroleum had been discovered in Pennsylvania in 1845, in drilling salt wells; but it was not until 1859 that, following the work of a chemist at Yale University, Benjamin Silliman, a company was organized and a well driven for the purpose of obtaining petroleum for illuminating and lubricating oils. This date marks the beginning of an industry, the significance and importance of which cannot be overstated. In 1869, J. W. Hyatt began the manufacture of celluloid, the first of the plastics which to-day add so much to the convenience and attractiveness of every-day life. It was not until 1872 that the manufacture of Portland cement was begun in this country. During this fifty-year period, coke had come to be used in the metallurgy of iron instead of wood charcoal. Railroading had become a large industry, and, incidentally, had found it necessary to employ chemists whose first service was in the standardization of the supplies purchased. The canning of foods and the manufacture of condensed milk had been started, as well as the manufacture of starch and glucose from corn.

We appreciate the significance of these industries, all of which grew up in this short time, when we think of how commonplace to us to-day are such things as rubber, petroleum products, concrete, and celluloid. The chemical industry of 1875 was still far from the industry of to-day. For example, the manufacture of chlorine was considered as one of the most important of the chemical industries, but it was then manufactured by a process which is now entirely obsolete; the manufacture of carbon bisulphide received much attention in chemical literature, its greatest application being as a solvent for rubber in those days. To-day, its principal use is probably in the manufacture of viscose for artificial silk; artificial silk had not then been discovered. Soda was not then manufactured in the United States, but was produced in Europe by a process which has been abandoned for years. One of the most important products of the fat industry was candles. The largest candle factory in the world was at that time doing business in London with a capitalization of $5,000,000.

On the other hand, the manufacture of soap was not even mentioned in this connection. Methods for recovering the glycerin, which had previously been thrown away, had been developed around 1858; but this was not noted by Smith, who perhaps did not realize its importance. Nitroglycerin and nitrocellulose had been discovered abroad and were beginning to find industrial applications in explosives, but their manufacture and application were so hazardous that they were obviously viewed with much apprehension. It is particularly interesting that nitrocellulose solutions are mentioned and the prediction ventured that photography might possibly some time become a chemical industry. By way of contrast, it suffices merely to mention the moving-picture industry of to-day, and the practically universal use of picture-taking equipment by the amateur photographer.

The use of petroleum products in lamps had resulted in some explosions on account of poorly designed lamps and improperly refined oil; and we again are struck with the progress made since that time, when we find a prominent American chemist in this period, Dr. Chas. F. Chandler, coming to the defense of kerosene as an illuminating oil in order to ward off proposed legislation prohibiting its use. "Certainly," he says, "an illuminating material which gives in a cheap lamp an amount of light equal to that of eight sperm candles and at a cost of one-third of a cent per hour, is an inestimable boon to the world. It adds several hours to the length of the day and enables the working classes to devote the long evenings to the improvement of their minds by reading; or where the labors of the day must be prolonged into the night, it saves the eyes from the inevitable ruin which would otherwise ensue. The sanitary advantages of a clear, smokeless light are inestimable. It is safe to say that petroleum is one of the great civilizing agents of the nineteenth century."

At the period when Smith wrote, the distillation of coal to give illuminating gas, coke, ammonia liquor, and tar was well established in this country; and chemists abroad were beginning to discover the possibilities of this coal-tar which had at first been only an objectionable waste product. In 1856,

the first synthetic coal-tar dye had been made by W. H. Perkin, Sr., in England, and alizarin dyes made synthetically had begun to replace the natural dyestuffs derived from madder. It was feared that the cultivation of madder was threatened, and with justification; for both madder and natural indigo were later replaced by the artificial product. The manufacture of phosphorus and its use in matches was mentioned, but there is no mention of the manufacture of fertilizers or of the importance of phosphates in agriculture. The electrochemical industries, which now form so important a branch of industry, were at that period undeveloped. Chloroform and chloral had been produced by the chemist, and the possibility of further contributions by chemists to medicine was suggested. The anesthetic properties of ether had then recently been discovered.

We see that fifty years had accomplished much. The industries were better organized. In the chemical industries in particular, there was more dependence on the findings of science; and scientific prediction, rather than purely empirical experimentation or inherited processes, afforded the basis of industries; notable examples of this progress were the development of synthetic dyestuffs and a new process for the manufacture of concentrated sulphuric acid, which at this period was beginning to be developed abroad.

Another twenty-five years brings us to the beginning of the present century, a date well within the lives of many of us; yet we may need to have the difference between living conditions then and now touched upon. In a comprehensive review of American commerce, published in 1895, and written by some of the most prominent men in American commercial life, we find chapters devoted to the bicycle trade and to the harness and saddlery trade; the influence of cyclists on the good roads movement is mentioned with pride; but there is no reference to automobiles nor moving-pictures, nor, of course, to aviation.

Yet by then the chemical industry had certainly acquired most of the characteristics which identify it to-day. It was conscious of its own possibilities and responsibilities. The scientific basis of most of the processes which it employed was

understood, and the value of chemical control was appreciated. The first real census of the domestic chemical industry, taken by chemists, was made in 1900. By the census, the term "chemical industry" was, of course, strictly construed; and it did not include the manufacture of glass, cement, foods, textiles, leather, or metallurgy; but excluding all these, which actually have their basis in chemical processes, the industry produced annually more than $221,000,000 worth of products, nearly doubling the value of the raw material used by it. And not only is the growth of the industry to be noted, but the steady lowering of the unit price of its products, which is the point of most significance to the man in the street, who is the consumer.

Many developments had taken place in the twenty-five years just passed. In 1880, Thos. A. Edison had invented the incandescent lamp. It was at first regarded by able but conservative scientists as an uncertain, if not dishonest, scheme for raising money by selling stock. By 1900, the use of incandescent electric lights was well established. The telephone had come into general use. Within this twenty-five-year period, the first bicycle had been manufactured in this country, and rubber tires had come to be used on bicycles and carriages.

One of the most important industrial chemical developments which occurred in the years immediately preceding 1900—a distinctively American development, by the way—was the electrochemical industry. The isolation of aluminum by electrochemical methods by a young American college student, Charles Hall, in 1888, changed aluminum from an exhibit in chemical museums at a price which rendered it useless commercially to a commodity from which the commonest kitchen utensils are made and which either by itself or in the form of its alloys has had countless applications. The electric furnace in the hands of American inventors also produced carborundum, used as an abrasive for sharpening tools, for grinding, and for polishing; all operations of great importance in a machine age, such as this. Graphite from carbon and calcium carbide, used for the manufacture of acetylene, are also electric

furnace products. In addition, the electric furnace has been applied to metallurgical problems as, for example, making ferrochrome, from which the valuable chromium steel alloys are made. A different field of application of electrochemistry was to aqueous solutions. The electrolysis of salt to give chlorine and caustic soda was first worked out successfully by Americans and has become the principal source of these important industrial chemicals. The refining of copper by the electrolysis of copper sulphate solutions is another important development; nowadays, practically all of this metal is produced in a very pure state by this type of process, of which nickel-plating was one of the earliest examples. Not including the metallurgical applications, this new industry produced over $2,000,000 worth of products in 1900, chiefly at Niagara Falls.

The subject of catalysis was one which had attracted chemists' attention a number of years before, and its possibilities in the manufacture of concentrated sulphuric acid had been mentioned by J. Lawrence Smith in 1874. By 1900, this process was on a sound basis in Europe and was soon after introduced into this country. A catalytic process for the manufacture of chlorine from hydrochloric acid had also been developed. One of the most important early industrial applications of catalysis in this country was in the fat industry. Ernst Twitchell, an American, found in 1897 that a catalytic process for splitting fats into their components, glycerin and fatty acids, offered many advantages over the older methods of boiling with alkali, one of the most important being that it enabled the glycerin to be recovered much more satisfactorily. With this valuable by-product, soap could be made more cheaply. Industrial catalysis was still a new field, however, and its great development took place in the twentieth century.

Other important American contributions to chemical technology were made by Hermann Frasch, who had developed methods of purifying petroleum oils which rendered usable the petroleums from the middle-western fields, which, on account of their sulphur content, had at first appeared unusable; and he had succeeded in developing a process for the mining

of the huge sulphur deposits in Louisiana which had long been known to exist but could not be reached economically on account of their depth. Frasch drilled wells and forced superheated steam under high pressure down these wells, the steam serving both to melt the sulphur and to force it to the surface. The process is in use to-day and enormous quantities have been produced, replacing the sulphur which was formerly imported from Sicily.

In the census of 1900, the explosives industry ranked fifth in the value of its products among the chemical industries. This is not surprising when the requirements for industrial explosives for the mining and construction work of a rapidly expanding country are considered. It is universally accepted that, without their aid, the growth of the country would have been much slower, railroad construction, water-works, and other big engineering developments being dependent on safe yet powerful blasting powders. Blasting powder was originally a black powder identical with the gunpowder known for many generations. It was not until 1856 that the increasing demands for blasting powder brought about the production of a special grade for this purpose at a lower price. This was made possible by one of the great contributions to black powder technology,—the substitution of the relatively cheap sodium nitrate for the potassium nitrate which had always been used. This was an American development long held to be impossible, but subsequently adopted throughout the world. Following the Civil War, a more scientific study of the ballistics of cannon powders had resulted in changes in the size and shape of the grains, which materially improved their performance. In 1874, the use of the higher explosives was just about beginning in this country. The Hoosac Tunnel, completed in 1875, was the first large engineering work to be carried out with their aid, liquid nitroglycerin, made on the spot, being used in this case. By 1900, dynamite was thoroughly established as an industrial explosive, having demonstrated its superiority over the older type of powder, particularly in the blasting of hard rock. The uncertainties in its manufacture and handling were eliminated, so that it ceased to

be a menace to those handling it. Smokeless powder, too, had been manufactured in this country by 1900, and American manufacturers had devolved a smokeless powder for small arms; but the Spanish-American War was fought by the American forces chiefly with black powder, the government departments not having adopted at that time the newer types.

In the 1890's, Leo Baekeland, a Belgian working in this country, had invented Velox paper, and by 1900, photography had become a pastime which the amateur might enjoy without excessive expense or inconvenience. The growth of the synthetic dye industry in this period marks one of the most striking developments in modern industry; although much of this work was done abroad, some of these manufacturing processes had been introduced into this country by 1900, though not on a very large scale. Chemistry had, moreover, made contacts with other activities in addition to manufacturing. The United States Department of Agriculture had been established and had started experimental stations in the different states through which the chemist was contributing to the solution of the problems of agriculture. Sir William Crookes, in England, had called attention to the fact that the known nitrogen resources of the world would not be sufficient for the agricultural demands of many more generations and that chemists must devise means for rendering available the nitrogen of the atmosphere. In this country, the government chemists had been particularly active in the study of food adulterations and of proper sanitary conditions in the manufacture of foods, and had brought about legislation protecting the public health. The problems of sewage disposal and water supplies for the large cities had been recognized and met with chemical aid. The Geological Survey was collecting data on the mineral and soil resources of the country, and in countless ways the chemist was influencing the daily life of the people, making life safer and more agreeable.

In 1900, an eminent American chemist, Chas. F. Chandler, was the president of the English Society of Chemical Industry; in July of that year he addressed them on the subject of chemistry in America, outlining the progress which had been made

in this country in his lifetime in chemical education, in scientific developments, and in the growth of the industry. He mentions the production of ores and minerals in this country, which in the year 1899 approached a value of $600,000,000; of metals which approached a value of $500,000,000; and of secondary mineral and chemical products valued at $64,000,000. Sulphuric acid production had reached a volume of over one and one-half million tons, large quantities being used in the refining of petroleum and in the manufacture of fertilizers. The latter had now become one of the most important chemical manufactures, with an output of one and one-half million tons. The production of salt had long been carried on in New York state, where deposits of great extent and high purity were available; and shortly before 1900, the first large-scale manufacture of soda ash was started in this country by the Solvay process, previously developed in Belgium. The glass industry had greatly developed, profiting by the supplies of high-grade raw materials available in this country and the higher grades of plate and cut glass and some of the art glasses were made here. Clay products to the value of $75,000,000 were made in this country in the year 1899. The cement industry had grown until there were forty factories producing over 6,000,000 barrels yearly.

Dr. Chandler outlined in a striking way the advances which had been made in artificial illumination within his own lifetime. As a boy, living in New Bedford, Massachusetts, the use of whale oil and sperm candles for lighting had appeared such a well-established industry that the possibility of its being supplanted had seemed ludicrous. The manufacture of illuminating gas from coal and then of kerosene from petroleum had followed, the result being practically to annihilate the whaling industry through the availability of these cheaper and better products. The development of the incandescent gas mantle had carried gas as an illuminant one step further in the impending competition with the incandescent electric light.

Sugar from both cane and beet was, of course, an important American product, and the use of corn for the manufacture of starch and grape sugar was a large industry consuming in

the year 1899, 35,000,000 bushels of corn for grape sugar alone. Another large outlet for corn was in the manufacture of alcoholic beverages, over 97,000,000 gallons of spirits having been produced in the year 1899.

In 1900, wood was still cheap enough to form the raw material of a considerable chemical industry. Potash was still manufactured by the ancient process of leaching wood ashes, a method now obsolete; and wood was distilled in large quantities to give charcoal, wood alcohol, acetic acid, and acetone.

In considering the progress made in the twentieth century, the pre-war period may be taken as a natural division. The growth of the chemical industry from 1900 to 1914 was marked by some striking developments, but more particularly by a strengthening of the industry as a whole, by improvements in technical efficiency, by the more general recognition of the chemist as a professional worker and by an appreciation of his possibilities in industries where his services had previously not been used. The chemical engineer came to be recognized as an essential factor in industrial progress. Within this period, the automobile, the moving-picture, and, to some extent, aviation, were commercialized; and to all of these the chemist contributed. The oxy-acetylene welding and cutting of metals was developed,—a technique of tremendous importance in an age of metals such as ours; and in metallurgy the possibilities of physical-chemical studies, especially in the development of new materials, began to be appreciated and yielded results in the form of new alloys and such special applications as the high-speed tool steels which made possible a greatly increased output in machining operations.

The widespread use of the automobile brought about a great change in the petroleum industry by its demand for gasoline. In the earlier period, kerosene had been the most valuable product obtained from petroleum; profitable ways of disposing of the gasoline were at first a problem. The advent of the automobile and the increased use of electric lighting entirely reversed this situation, and the attention of the refiners was directed towards obtaining the largest possible yield of gasoline. This was accomplished by improvements in distillation

and finally by the development of processes for cracking the petroleum under pressure, decomposing some of the less valuable constituents into volatile products usable as motor fuel.

This period marks the real beginning of the industrial utilization of catalysis. By "catalysis" is meant a reaction brought about by bringing into contact with the reacting substance some material which may either determine the nature of the products by bringing about the desired reaction, or merely serve to greatly hasten the desired reaction. This material, which serves to promote the desired reaction, is called a "catalyst," from two Greek words,—"kata," meaning entirely, plus "lyo," meaning loose,—signifying that the catalyst does not combine with the final product, but remains, after the reaction is finished, entirely loose, uncombined, and usually in the original form in which it was introduced, though sometimes marked changes in the physical appearance of a used catalyst are noted. The manufacture by a catalytic process of a highly concentrated sulphuric acid, necessary for many of the newer chemical processes, was mentioned by J. Lawrence Smith in 1874; but it was not until after 1900 that the process was introduced into this country. Here improvements were made which have finally placed the United States in the front rank as the largest manufacturer of sulphuric acid in the world, and probably the most efficient. Another new catalytic process of great industrial importance resulted from the discovery that certain liquid fats or oils, when treated with hydrogen in the presence of a nickel catalyst, were converted into solid fats of much greater value. These were usable, if of sufficient purity, for foods in the place of lard, and in the manufacture of butter substitutes; or, with the lower grades of materials, in the manufacture of soaps. This meant also that some oils, formerly of almost no commercial value, such as certain fish oils, could now be used. A large and cheap supply of fats is essential to modern civilization, both for foods and for making soaps. By this process the chemist has made us largely independent of a diminishing supply of animal fats.

The problem of fixing atmospheric nitrogen in forms which would render it suitable for agricultural and chemical manu-

factures was one which from the beginning of the century engaged the attention of chemists throughout the world. C. S. Bradley and D. R. Lovejoy, American chemists working at Niagara Falls, demonstrated in 1902 that it was possible, by means of the electric arc, to transform the nitrogen of the air into nitric acid; and they were the first to develop a nitrogen fixation process on an industrial scale. Although this idea later became the basis of the great Norwegian industry, financial support for its development could not at that time be obtained in this country. The process which was really the first to be used commercially in this country depends on the fact that when nitrogen is passed over incandescent calcium carbide, it combines with it, forming a compound called cyanamide. This compound may be used directly as fertilizer, or it may be treated with steam to form ammonia, from which ammonium salts may be made.

This period is also marked by the production of another new raw material by the chemist. Early in the century, there was produced from phenol and formaldehyde a synthetic resinous substance now generally known as Bakelite, because of the important part played by Leo Baekeland in its development. Previously, the attention of chemists had in general been directed to pure materials which were either liquids with known boiling-points, or crystalline materials having definite melting-points. Resins, on account of their complexity and lack of these definite properties, had been difficult to study; and this synthetic Bakelite represented a start in a new direction. The fact that it had high electric insulating power, that it was mechanically strong and non-inflammable, and that it could be readily molded under pressure and machined, adapted it to many manufacturing processes in the industrial world and to the production of many novelties and utensils for which amber, horn, shell and celluloid had previously been the only available materials. This American invention was indeed the foundation of a new industry; the use of synthetic resins is now world-wide and constantly increasing as new products are developed by the chemist to meet special requirements.

Early in the century, an American, F. G. Cottrell, invented

a process for electrically precipitating smokes and fogs. This process found its greatest application in the recovery of acid sprays and mists from huge factories. In some regions, notably where large smelting operations were carried on, the sulphur gases given off destroyed all vegetation for miles around. The application of the Cottrell process has not only removed the public nuisance in such cases but the acids recovered in this way are sufficient in quantity to represent a considerable value.

The chemists also continued the improvement of artificial lighting. The incandescent carbon filament lamp was replaced by lamps with tungsten filaments having much greater light efficiency, and the manufacture of ductile tungsten for making these filaments cheaply was developed in this country. Then, as a result of further chemical investigations, there came the present gas-filled electric light.

In the explosives industry the significant developments of the pre-war period were the production of explosives which could be used in gaseous and dusty coal mines with far greater safety, and the use of manufacturing processes which were at once safer and more economical. This meant, first of all, the saving of the lives of workers, and second, a greater reduction in the price of industrial explosives which were used in increasing quantities. Smokeless powder was developed until it became the accepted ammunition for military use, and was also widely used in sporting powders.

The outbreak of the World War and the cutting off of importations gave a new and great impetus to the chemical industry in this country, the effects of which were by no means confined to the war-time period but have been the basis of a great post-war development. Obviously, there were special requirements in the way of explosives and other supplies needed directly by the fighting forces. In the case of propellent powders, an enormous increase in the production of smokeless powder was required; and the unprecedented use of high explosives resulted in a rapid and tremendous expansion in this country's facilities for the manufacture of high explosives. The manufacture of T.N.T. and of tetryl and of picric acid,

which had been carried out on a small scale in this country previously, now grew to huge proportions, in order to make available adequate supplies of these disruptive military explosives. This great increase in explosives production meant similar increases in the closely related industries, such as the manufacture of nitric and sulphuric acids and of the organic materials, especially by-products from coke ovens, from which some of the new explosives were made.

But, in addition to military supplies, there were the requirements of the civilian population for dyestuffs and for medicinals which, developed by the chemist, are playing an increasingly important part in modern medicine. The growth of the synthetic organic chemical industry in this country has been so rapid and so successful that its rise constitutes one of the most striking chapters in American industrial history. The production of dyes is first thought of in this connection; and we are now making in this country about twice as much as was consumed here before the war. In addition the American chemist has to his credit the improvement in quality and lowering of price of many of the colors. But the synthetic organic industry is not limited to dyestuffs.

The raw materials such as benzene, toluene, and naphthalene, which serve as the starting-point for the modern disruptive military high explosives,—T.N.T., tetryl, picric acid, and the like,—these raw materials are the starting-point in the manufacture of a very large number of synthetic dyestuffs. Perhaps even more important is the fact that the technique and the scientific information, or, as the chemist would say, the chemistry of these materials, is to a considerable extent shared by the high explosives and dyestuffs industries; that is to say, the same chemistry which results in the manufacture of new types of explosives and poisonous gases for warfare, has developed products of great industrial value when applied to peace-time problems. In addition to this, the initial processes of manufacture and the equipment required for carrying out these processes are, in many cases, identical, whether the material is to serve for a high explosive eventually, or is to follow other forks of the road and serve, eventually, as a dyestuff, or

a flotation agent, or a pharmaceutical, or is to be used in the rubber industry. For example, makers of dyes have also made improved accelerators for the vulcanization of rubber, greatly shortening the time of vulcanization and therefore increasing the output and lessening the price. More recently, they have found that the addition of special organic substances to rubber compositions will greatly prolong their life. The organic chemist also produces flotation agents, which have resulted in enormous economies in the concentration of certain types of ores; he provides materials with which the farmer fights insect pests and parasites; and one of the most welcome applications of this type of chemistry has been to the manufacture of drugs of such efficacy that they cure or alleviate diseases to which mankind had previously been an almost helpless victim.

During the war, attention was actively directed to nitrogen fixation problems which were of definite military, as well as peace-time interest, nitric acid being an essential in the manufacture of explosives; and nitrogen fertilizers a necessity for modern agriculture. These efforts did not in this country result during the war in the establishment of any such enormous enterprise as was established in Germany; but the studies were continued, and the direct production of ammonia from the air is now an industrial process in this country and appears to be the method of nitrogen fixation which will be responsible for the supply of synthetic nitrogen of the future; though if this country had been faced during the war with the necessity of fixing nitrogen in large quantities, it would doubtless have depended on the cyanamide process which has been mentioned. The method of converting synthetic ammonia into nitric acid by burning it with air has also been commercialized, so that the question of a future nitrogen supply need no longer cause anxiety. The problem of the world's supply of fixed nitrogen referred to in 1898, to which no chemist could then give the answer, has within less than thirty years received an answer which we may consider complete, though doubtless not the ultimate one.

This synthesis of ammonia is indeed one of the great triumphs of the chemical industry of this country. Its accom-

plishment involved the development of a new technique for using much higher pressures than had previously been employed in manufacturing processes and a much more intimate knowledge of the behavior of the catalysts which play a vital part in it. Once this technique was perfected, it was found that other syntheses were possible by similar means and that, for example, methanol could be made very cheaply and in a high state of purity from a mixture of carbon monoxide and hydrogen. These gases are the important constituents of water-gas, which is made by blowing steam through burning coal. This synthetic methanol process, developed abroad but quickly adopted in this country, marks a new era in industrial chemistry, placing in the hands of the chemists the possibility of producing cheaply and on a large scale, materials which had previously been obtained only from growing things. Methanol had previously been produced only by the distillation of wood, and considerable quantities are still made in this way. It became at once evident, however, that the development of the synthetic process must mean the eventual extinction of the wood distillation industry, the demand for charcoal being very limited, and the other valuable product of this industry, acetic acid, having been successfully produced by large-scale synthetic processes. Calcium carbide, a product of the electric furnace, gives acetylene when treated with water; and this the chemist, by a series of catalytic processes, converts into acetic acid. Thus the distillation of wood is certain to be another industry supplanted by the progress of chemistry; like the extraction of natural indigo and madder from plants and the rendering of whale blubber to yield oils for lighting and for lubrication.

The exigencies of the war brought the manufacture of nitrocellulose to an unprecedented volume, though the attention of chemists had long been directed to the possibilities of cellulose as a raw material. As one eminent chemist in this field has expressed it, "We are living in a chemistry of air and water to which cellulose might be added as the third preëminent substance,"—and even before the war, the cellulose industries of Great Britain ranked next to their iron industries in the value

of their products. This raw material, supplied in such abundance by nature, has been converted by the chemist into an almost infinite variety of forms. Explosives and celluloid were the earliest applications of chemical derivatives of cellulose; later, coated textiles were developed, imitating leather so perfectly that only extremely careful examination can differentiate them from real leather. These products find wide application in the field of upholstery for which the supply of natural leather would be entirely inadequate. A recent important American development is the application of nitrocellulose to the manufacture of quick-drying finishes having a beauty and permanence which, in the finishing of automobiles, for example, has enabled them within a few years to supplant almost completely the oil paints and varnishes which had previously and for many years been in use. The introduction of this type of finish indeed has meant a complete change in the technique of industrial painting, resulting in striking economies in production, and it has placed in the hands of the consumer a more durable and satisfactory product. Another result of cellulose chemistry is the astonishingly rapid development in this country and throughout the world of the manufacture of rayon, the first synthetic textile, having the beauty of silk yet produced at a price which makes it available to every one.

The growth of the nitrocellulose industry has necessitated the development of other industries supplying it with raw materials, the most notable chemical development in this line being the manufacture of those organic materials which serve as solvents. The production of butyl alcohol and acetone by fermentation processes was developed during the war period and now provides an outlet for large quantities of corn. Economies have been effected in the large-scale chemical production of such compounds as ethyl acetate; and other organic compounds of the solvent type are made from gases formed from petroleum or given off in the distillation of coal.

In an entirely different field and working with distinctly different methods, the metallurgical chemist has accomplished results which are no less striking, and are of immense importance in a civilization which uses metals to the extent we

do to-day. In the automobile and the airplane industries, for example, there have been special requirements which could be met only by the development of new materials,—alloys having in a marked degree some specific property such as strength or lightness or hardness or combining several such properties. Achievements in this line of especial interest to the chemical industry are the development of materials which, to a marked degree, resist the corrosive action of acids. Examples of materials of this sort which have come to the attention of every one are the stainless steels used for cutlery. Other alloys of great commercial value are designed to withstand especially high temperatures.

Another distinct field in which the American chemist has made striking progress within the last decade is in the manufacture of the higher grades of glass. Before the war, we were almost entirely dependent on imports for our supply of optical glass, a high grade of which is now produced in this country; and the development of a specially heat-resistant glass, Pyrex, is an American accomplishment familiar to every housewife and to every user of technical glassware.

Reference has already been made to the development of cracking processes for petroleum, resulting in a larger supply of motor fuels from petroleum. A further improvement in the efficient use of motor fuels was made when American technologists discovered that the addition of very small amounts of certain chemical compounds to motor fuels would prevent knocking, and thus enable engines to be designed for higher compression and, therefore, greater fuel economy.

In the rubber industry, the chemist has discovered methods for using directly the latex, the sap of the rubber tree, without going through the process of first making a crude rubber; more recently it has been found possible to electroplate rubber somewhat as nickel is plated. Thus chemistry is steadily increasing the use and value of rubber. It is even possible to synthesize in the laboratory materials very much like rubber, but so far this has not been developed to the commercial scale.

Looking back over the century we can see that chemical industry, which started in a few laboratories and workshops, has

grown until every phase of our material existence has been profoundly altered by it. It has contributed new materials and improved and lowered the cost of the old. Processes, then not developed, have now become obsolete, and products unthought of in the earlier years of the century are now commonplace. The figures given by the "Friends of Domestic Industry" in 1831 for the entire American chemical manufactures comprised thirty establishments employing 900 hands and producing $1,000,000 worth of products. In the year 1925, the rayon industry alone,—a synthetic fiber manufactured by chemical processes, and an industry not even dreamed of in 1831,—this new industry comprised fourteen establishments in this country, employing more than 20,000 people, and the value of the product was $88,000,000. Still more impressive is the total value added to the material passed through the chemical industries. The increase in value of these materials, according to the Bureau of the Census Reports, for the year 1925 was $6,655,575,000. This figure is exclusive of the increase in value imparted to the products by metallurgical processes. The figure for the increase in value imparted to products of metallurgical manufacturing processes was stated to be $527,862,000. The total increase in value of the products for chemical industries and metallurgy is, therefore, $7,183,437,000. Finally, the value of the products of American industries which have a chemical interest amounted, in 1925, to $21,021,875,000, exclusive of the metallurgical industries which produced products valued at $2,479,968,000. This total for the value of the products of the chemical industries and metallurgical industries of $23,501,843,000 may be compared with the figure for $1,000,000 worth of products given by the "Friends of Domestic Industry" in 1831.

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XVIII

DEPARTMENT STORE MERCHANDISING

By Jesse Isidor Straus
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AT the beginning of these hundred years which we are considering, the typical American home was still a fairly self-contained unit in an equally self-contained country. The housewife spun, wove, sewed, bleached, baked, preserved, made soap, dipped candles and, above all, *recognized few necessities which her energy and ingenuity could not provide.* As producer she knew exactly what her consumption needs were; as a consumer she knew thoroughly the contents and the workmanship of her products. In such an economy, store-keeping played a minor rôle of small units and restricted stocks.

At the end of these hundred years we find a totally different picture. Consumption has remained at home with the housewife, while production has become a wanderer and ranges the four corners of the earth. The whole category of verbs describing household industries has been replaced by the single verb:—*buy.* With this change in physical function has come a significant change in mental attitude. The housewife has lost her familiarity with the processes of manufacture and has become dependent on what she is told about things, and her "needs" are now restrained by the size of her purse rather than by her energy and ability.

As time and space have entered as factors between production and the consumption which is the sole purpose of production, the basic relationship between these two functions has been somewhat dimmed. Production sometimes assumes that

it is an end in itself, with factory capacity as its only restraint, rather than as a means to an end, with consumption ability as the measure of its volume. Between these two poles of industry, the distributive system is the connecting link and its efficiency controls in large measure the producer's prosperity and the consumer's standard of living.

To translate the mass output of some great plant whose problem is disposal of its product by the ton into the needs of a far-flung line of consumers whose problem is satisfying their individual wants by the pound: that is the function of distribution in which the department store and the mail order house are but two of many factors. Every mile that production has been removed from ultimate consumption must be retraced by the finished product; during every hour that intervenes between production and consumption the product must be cared for. Questions of transportation, storage, refrigeration, insurance, finance, display, final sale and delivery enter this picture both as essential functions and as necessary costs. Whether performed either by the producer in a factory-to-consumer sales system or by the large retailer who buys direct from the manufacturer, or divided between wholesaler and retailer in the normal flow of distribution, these expenses must be added to the cost of production before the price to the ultimate consumer can be fixed. And these secondary cost items are increased by the growth of conveniences and privileges expected by customers in making purchases and in having them delivered. Thus in one way or another goods accumulate certain expenses on their journey from producer to consumer, whether the services rendered for these costs are performed by independent middlemen or by specialized employees.

It is therefore well to bear in mind that the modern economy which has been developed on the basis of mass production is subject to certain laws of distribution which are as immutable as the laws of physics and chemistry. They cannot be ignored. They can be studied, mastered and applied to make distribution more efficient, just as the physical laws have been mastered in the tremendous development of mass production.

In this more scientific approach to merchandising, the de-

partment store is playing an important rôle. Like Topsy, it has "just growed." Now it is beginning to direct its growth.

II

The New York which witnessed the formation of the American Institute had already established its leadership in the New World and thus happily provides an appropriate situs for an examination of the roots of the department store idea. This bustling young town was already a busy seaport receiving cargoes from the Old World, the Far East and the West Indies. Some of these cargoes were owned either by the trader-captains of the ships or by the owners of the fleets; others came on consignment to local agents. In either case the cargoes were frequently broken up and disposed of by auction, the buyers being either local merchants or wholesalers who distributed to the merchants of such towns as Albany and to the itinerant peddlers who carried their packs by trail and boat to the scattered settlements and solitary homesteads.

This same New York was also showing a decided trend towards commercialization of those homecrafts which are peculiarly domestic. It is reported that John Jacob Astor began his career as a baker's apprentice and peddled cakes and tea-rusks from door to door. Although Manhattan Island was still preponderantly farmland, one young merchant laid the foundation of his later prosperity in a firkin of butter which he bought at the market and retailed in small quantities from a second-story hall bedroom which also served him and his wife as a residence.

Joe Bonafanti kept the original variety store in New York and a chronicler of the times relates that a southern visitor wagered a New Yorker that he could name an article not in the stock of this unique emporium. The test selected was a request for a pulpit, and a second-hand one was immediately forthcoming.

Also in this story is the significant fact that Bonafanti handed to each customer "a new poem on a sheet just printed that day," and the narrative concludes with:

"Bonafanti and his splendid stock and harmonious poetry made himself a great favorite with the fashionable dames of New York. A fan, or opera gloves, card-case, pocket-book, purse, eye-glass, must be purchased of Bonafanti. . . . That poetry was deemed wonderful, and it would have been had it been written by Bonafanti. But it was not. The mad poet, McDonald Clark, wrote it, or Woodworth, the poet. The author of 'The Old Oaken Bucket' was alive and poor at that time, and I think he was one of Bonafanti's poets, for in after years, the sons of the poet Woodworth succeeded to the business of Bonafanti." [1]

Into this simple economy came steam and then machine tools; steam to run the mills and trains and machine tools to speed up production and transportation through the construction of more efficient machinery. Population began to pile up in each industrial center and to draw from an ever-increasing radius for the things not produced in that center. New York continued in the forefront of this new development and the better shops shared in the growing prosperity.

These shops were of two general types: what are now called "unit stores" which handled a single type of goods and the general stores in which, as in the case of the estimable Bonafanti, one could buy everything from a pulpit to a fan. The "general store," which was more characteristic of the small town than of the city, became a unique feature of the social and political life of the country as well as serving an economic function, and one need not be a grandparent to remember the importance which the cracker barrel and the cracker-barrel philosopher of the "general store" enjoyed—and, to a not inconsiderable degree, still enjoys—in American life.

But the increasing complexity of distribution developed the basis of merchandising as a science rather than a philosophy; although business was slow in analyzing and recognizing this situation. The department store idea sprang from the stronger unit stores through the process of agglomeration rather than from the general stores through the process of parturition. In most cases shops which were selling one line of goods successfully added another line and, in due time, others. As stock

[1] *The Old Merchants of New York City*, by Walter Barrett, Clerk.

expanded, the store front lengthened by the expedient of taking over the ground and second floors of adjoining dwellings; for it was one of the legends of storekeeping that only two floors were suitable for this business. The result was a straggling collection of shops in which business was carried on with varying degrees of native shrewdness and a universal lack of comprehension as to what it was all about.

Manning the unit stores and the various collections of shops were a retired sea captain, an immigrant who had clerked it in Ireland as a lad, an itinerant peddler who had grown tired of the road, to describe only a few of New York's merchant class. Each brought to his job a native wit and luck, and through trial and error developed a certain lore of shopkeeping, which was passed on to the succeeding generation. But there were no studied technique, no efforts towards standardization, no literature, and but little public discussion. Production was still so recently a household experience that the rule of *caveat emptor* was easy for the storekeeper and not too hazardous for the still knowing housewife. Indeed, the real criticism of this now obsolete rule is its harmful effect on the seller rather than on the buyer.

At this time the tremendous growth in production, transportation and immigration created a prosperity which pushed retail merchandising ahead. There was great material growth in the stores but the merchants remained intellectually stunted insofar as any scientific appreciation of their economic function was concerned. Whenever one of the periodic business depressions occurred, this push from behind stopped and a few merchants dropped out; others who should have dropped on the basis of their business methods were bolstered up by the increased value of their real estate. At the same time those who had listened to the call of the steam whistle in the factories and on the rails were facing their problems, trading experiences, putting their houses in order and growing in mental stature with the growth of their great machines.

So there developed this uneven distribution of brains to work with the productive power of machinery and of brawn to cope with the output of that coöperation. In the half century

between 1870 and 1920 the proportion of persons engaged in the various processes of distribution to all those gainfully employed increased from 12 per cent. to 30; and this trend continues.

III

Although distribution admittedly faltered during three-fourths of this century of industrial progress, at least it functioned sufficiently well to permit the enormous expansion of productive energy which has made American progress so notable; and now it is developing the technique, the literature and above all the leadership which must be fundamental to a scientific approach to its problems. On this new basis it is competing for that type of mind and imagination which heretofore found its best chances for expression in production methods and management. As it learns to speak with the authority of facts thoroughly analyzed and carefully correlated, distribution will have definite things to say from its middle ground to both producer and consumer; for many of distribution's acutest problems are seeded in the time, the place, the nature or the amount of production, while others derive from the ignorance and credulity of consumers and the lack of discipline among them.

Yet we cannot leave this earlier phase without more specific acknowledgment of the rich lore of storekeeping which the present generation has inherited as background for its more scientific approach to merchandising. The period immediately preceding, during and following the Civil War was the middle phase in this first century of great industrial expansion and it gave the country four merchants who left a definite impress on the young nation and its methods of doing business.

Alexander Turney Stewart, for example, may well be said to have flourished during this middle phase. Born in Ireland at the dawn of the nineteenth century, he had found his way to New York via New London, Conn., as a young man. Through connections in his mother country he established himself as an importer of Irish linens. The story is still handed down in one of the old New York families that A. T. Stewart

came to Moses Field and asked to rent one of the latter's buildings for a store. Inquiry developed that young Mr. Stewart had no security to offer beyond his word and his personality. They seemed tangible assets to the shrewd Field, and the deal was on. When Stewart opened his store at Broadway and Chambers Street, New York was electrified by the break with the "monger" tradition of store policy. Here was something that was great. Here was a "marble palace" devoted to commonplace trade. Here there came to be clerks by the scores; yes, by the hundreds. Yet it became well known that these clerks were expected to treat with special consideration and courtesy ill-dressed and unprepossessing persons who would make only trifling purchases. Stewart had sensed without the aid of formal psychology one cardinal principle of his business; that is, that the successful store must develop a distinct personality, must become an institution. He was rewarded when New Yorkers advised their out-of-town friends to visit Stewart's.

This was by no means a box office showmanship, however. Stewart's conception of the merchant's function in society also included definite responsibilities to society. During the Civil War he bought up the production of several large textile mills in New England and sold at low cost the uniforms which he manufactured. When the price of textiles soared he advanced his prices with rare moderation. When his Southern debtors wrote that they would refuse to pay him if he lent money to the Union government, he put the loan through at once. His faith in his city of adoption made him one of the very largest owners of New York real estate and led him to move his store uptown to Ninth Street at a time when public opinion considered such a move foolhardy if not suicidal.

With Stewart's death in 1876 his great store passed into other hands, languished and finally failed. In the meantime another distinctive department store had been firmly established in New York. A few years prior to the Civil War a Massachusetts Yankee had established a small shop just below Fourteenth Street on Sixth Avenue. Captain Rowland H. Macy had all the trader instincts of a New England back-

ground, yet it was he who contributed to the lore of retail merchandising the cash policy with prices clearly marked and strictly adhered to. All customers were put on an equal plane and no discounts were allowed to special groups or favored individuals. The story is told that a good friend dropped in one day to make a purchase and, finding he had left his wallet at home, asked if he could postpone payment until the morrow. This Captain Macy refused as being against store policy; but he transferred from his own pocket to the store till the sum involved, thus making the transaction a personal loan from one friend to another rather than an extension of credit from store to customer.

A contemporary of Stewart's, Captain Macy was identified with New York only in the last few years (1858-1877) of his career. Yet he left a definite mark upon the business life of his day and established principles of retail merchandising, which are as characteristic of the Macy store to-day as they were when he started business here threescore years and ten ago.

In the neighboring city of Philadelphia, John Wanamaker had set up as a storekeeper in partnership with his brother-in-law four days before Fort Sumter was fired on. When war was actually declared he volunteered for service but was rejected because of his weak lungs. When he had run errands for his mother during the gawky period of boyhood, well-dressed women in the fine stores of the period had stared at him and made him self-conscious of his hands and feet. He had then resolved to own a store when he grew up and make it "easy to get into, and easy to get out of," as well as a place where all customers would feel at home while they were there.[2] Perhaps this boyhood experience was of real importance in molding the career of one of America's greatest merchants, for later as a lad of fourteen he worked at the printing trade, like another great Philadelphian.

To the then simple job of storekeeping young Wanamaker brought the constructive imagination and courage of the born innovator. It is reported that he studied with a veteran clerk

[2] *Romantic Rise of a Great American,* by Russell H. Conwell.

of the Hotel Continental to learn how hotel men trained themselves to remember patrons. Also, that the first day's receipts of his store being $24.67, he left the 67 cents in the till to make change the next day and invested the $24 in advertising. Cash refund for returned merchandise, free delivery of purchases and the installation of such service features as rest rooms and telegraph and postal offices for the use of his customers were typical of his contributions to the development of retail merchandising. A restaurant was made a feature of his growing department store, and he is said to have told his restaurant manager that he could afford to lose $10,000 a year on mince pies alone, if this were necessary to maintain the high standard of the restaurant. At the same time he was turning his attention to employee problems which were increasing in type and complexity with the growth of the department stores. The practice had developed among storekeepers of paying their clerks in large part by orders on other stores for butter, vegetables and other necessities. On these orders the issuing stores received a commission. Wanamaker broke with this practice and paid cash to his employees. He also led in shortening the business day for stores and their clerks.

His partner, Brown, having died in 1868 (only seven years after they had joined in business), Wanamaker shared with no other principal the credit for the innovations which made Wanamaker's of Philadelphia a national institution. Although the Centennial Exposition was held comparatively early in the store's career, it is said that many out-of-town visitors admitted frankly that they had come to Philadelphia for the Centennial but had preferred to go to Wanamaker's. The appointment by President Harrison of this noted merchant as Postmaster General was popularly approved and when Wanamaker entered the New York field in 1896 by purchasing the old Stewart building, it occasioned the greatest interest. By that time the shopping district had leap-frogged over the Ninth Street location of Stewart's and was well entrenched on 14th and 23rd Streets. Nevertheless Wanamaker was so content with the site that he built a large addition, and Wanamaker's

of New York still remains between Broadway and Astor Place despite the steady drift northward of the shopping center. This is interesting when one remembers that this Ninth Street location was called too far uptown when Stewart moved to it and too far downtown when Wanamaker started his New York development.

The other outstanding figure of the middle phase of department store development was Marshall Field. Born in 1835, he went to Chicago at the age of twenty-one after having "clerked it" in a country store in Western Massachusetts. Hardly had he begun work for a wholesale dry goods house when the panic of 1857 developed; in the subsequent reorganization of the firm Field was made a junior partner. Immediately following the Civil War Field organized the firm of Field, Palmer & Leiter from which Palmer withdrew in 1867 and Leiter retired in 1881. Thereafter the firm was Marshall Field & Co. and as such became one of the great beacon lights of the growth and prosperity of the Middle West. Exclusive of an important wholesale business in dry goods, the company has held for years the record for sales volume in a single department store, and "Marshall Field's" is national in its prestige.

The genius of this great merchandising development was a man of rugged business principles. To him credit was a thing to be extended only under most rigid conditions, and never to be asked for. He bought for cash and avoided debt as the cornerstone of his business policy. His contemporaries credited him with being an important factor in keeping the methods of trade in the West toned up to sound business principles.

Indicative of his business leadership is an incident of the great Chicago fire of 1871. At that time the business of Field, Leiter and Co. (Palmer had already withdrawn from the partnership) was only six years old. While the fire was still raging northward, the firm rented a street car barn as temporary quarters. This example did much to restore public confidence and other firms followed suit, but the glory was Field's.

As a merchant he believed in getting the best goods, telling

the truth about them without misrepresentation, and seeking always to have things a little better than the demand for them. As an employer of a large force of salespersons, however, he was content to remain in the old school, and his contribution to progress in department store personnel management was slight.

Such were the most picturesque and successful leaders in bringing store-keeping out of a Dickensian atmosphere and putting it on a basis comparable with the developments in mass production. Meeting a competitive situation in which small capital and less training were sufficient assets for any one to start a retail shop, they built up great distributive units offering wide assortments of stock, employing thousands of employees in buying, selling and service, and spending huge fortunes annually in advertising. Each was a pioneer, an innovator in his own right. Through traveling buyers they made the whole world directly tributary to their warehouses. Through great delivery systems they reached out for trade over an ever lengthening radius. Between these two complex functions they developed huge store buildings and sales forces as focal points in the flow of goods from mass production into individual choice and consumption by the masses. They fought their battles with opportunity in each case as light and courage were given them, and they and their type have contributed to American life a splash of color which becomes more vivid as attention swings to the vital importance of distribution to our national well-being.

IV

Perhaps the first real recognition of the distributive system as a national problem was the meetings called in Washington in 1917-18 as a World War measure to determine how economies in distribution could be effected to release man power for war purposes. A decade prior to that, the Harvard School of Business Administration had been launched as a graduate school comparing favorably with the advanced schools of technology in standards of teaching and research. The introduc-

tion of the case method through which real problems of going business concerns were studied and commented upon by both students and teachers, and intensive research into the marketing problems and methods of various businesses became the foundation for a growing literature for distribution.

With the development of the Department of Commerce as a separate governmental function, this informational service and leadership to all business was greatly enhanced and the retail merchandising field shared in these wider opportunities for self-study and interchange of experience. At the same time the trade press, headed by certain outstanding publications, developed from a parasitic existence into an active factor in a new era for merchandising. And, most significantly, the retail stores, which were traditionally individualistic enterprises, began to recognize their common identity of function through the formation of trade organizations of which the National Retail Dry Goods Association and the Retail Research Association are notable examples. If the history of the older professional groups is a safe guide, this banding together of erstwhile individualistic merchants for mutual aid in attacking common problems is the first great step towards the creation of the group standards of ethics which are the basis of the professional attitude.

Approaching the problem from another and more interesting angle was the establishment in Boston of the Prince School for training young women to become in turn special teachers for salesclerks in an increasing number of stores. As retail selling is a highly personalized service to the customers and as stores have grown in size until the only direct contact between proprietor and customer is through the salesclerk, the general personality and specific intelligence of the clerk are matters of supreme importance. The attention being given to this problem is implied in the development of training departments in the stores, as well as in the success of the Prince School.

At the same time we can note encouraging tendencies among the ultimate consumers who are the customers of the retail merchants and whose intelligence and discrimination in buying have an obvious effect upon the intelligence and standards of

selling. This consumer group descends directly from the original production group in so far as are concerned all those things once made or prepared in the home; but this "descent" has been so complete under the stimulus of mass production that little knowledge is left of the processes of manufacture. At the same time the high earning power of the average American family plus the democratic impulse to live as well as, and a little better than, one's neighbor, has greatly broadened the scope of "needs" which are satisfied on a basis of emotion and credulity. These are fair game for the producer and his advertising agent. Federal and state legislation affords some protection in the cases of harmful ingredients and of false weights and measures; group associations among the producers are beginning to standardize their products; and the better publications are exercising a certain censorship over the statements which are made in their advertising columns. But the most hopeful corrective is the increasing discussion of merchandise in the daily press and periodicals. Although fashion continues as the most popular topic, staple goods and the growing field of such housekeeper's utilities as vacuum cleaners, washing machines and mechanical refrigeration is being more and more honestly discussed on the women's pages of the daily papers and in the magazines edited primarily for the women who are the housekeepers and the shoppers for America.

V

The department store, as the great convenience store for persons living in or near large towns and cities, is an outstanding development in the distributive system which has served a century of tremendous productive progress and of rapid urbanization of the population. Its departments form the great mosaic from which the smaller mosaics of countless individual homes are made. In a real sense it is the scout which the housewife has sent out after those original homecrafts which she progressively relinquished to mass production. Its function is to satisfy her wants in terms of the manufacturers' abilities. Its greatest problems are due to the fact that the

housewife's wants are no longer disciplined by her capacity to produce, and that the producer's ambitions are no longer restrained by a single, definite market for his output.

It is these problems which constitute the challenge and the opportunity to large-scale retailing as exemplified in the modern department store. Producers' activities have satisfied new needs in a progressively higher standard of living, then have rung the changes on those needs by offering imitations, substitutes and alternatives, and, finally, have carried this kaleidoscopic picture direct to the consumer through forceful advertising. In the face of this clamor the retailer must make his choice. He can relinquish all selective and advisory functions and become merely a vending machine, or he can exert leadership on producer and consumer alike.

The price of such leadership is manifold. In the first place, to serve its purpose in the distributive system, a department store must be conveniently located. This means a central location and high rents. According to the regional plan survey conducted by the Russell Sage Foundation, the best retail businesses occupy the highest priced realty in all cities except such great financial centers as New York and London where the central banking districts use slightly more valuable land than do the best shopping centers. Whether the use of this land is paid for in rent or in property investment, the cost is an outstanding item in a department store's overhead.

In the second place the store must be designed to serve its customers efficiently and quickly. This means carefully arranged display furniture, special conveyors for clearing purchases for delivery and replenishing stocks on display, arrangements for receiving cash and making change, and, above all, facilities for moving customers expeditiously to any part of the store. Here are devices in design and equipment which will compare in importance with the layout of a great manufacturing plant.

In the third place, the store must have on hand what the individual customer wants when he wants it, a nice problem in anticipation of demand, which is hedged in by the penalties of overstocking and understocking and heightened by the

whimsies of fashion in everything from colored pots and pans to Oriental rugs and evening clothes. In the fourth place comes the whole field of advertising, window display and other sales promotion, and it is a highly technical and expensive factor. Next, the store must have the ability to carry through sales with satisfaction to the customer, a problem involving the efficiency and personality of thousands of salesmen and saleswomen and also involving shopping habits which multiply at least a hundredfold the customer population between, let us say, a Monday morning in August and a Saturday afternoon before Christmas. And, finally, comes the matter of delivery which, in the case of one New York store, involves one central and nine branch depots and some three hundred automotive trucks averaging 8,500 miles a day on city and suburban routes.

These are all essential elements in the price of leadership for the good reason that they are the only basis upon which a following can be developed and retained in the most highly competitive field of American business. Any man or woman can become a retailer almost at pleasure; for there are plenty of landlords who will accept a tenant on the basis of the first month's rental, and there are plenty of manufacturers' sales representatives who will be glad to put their products into a store's display without too careful inquiry into the merchant's credit. Hence failures with resulting receivers' sales are a depressing factor in an orgy of unrestricted and irresponsible competition which still characterizes the retail merchandising field. Such disorganization would seem to be to the consumer's advantage, but in the long run he pays the bill; for failure means losses which a continuing business must make up, and the business of retail merchandising must continue.

Blame for this high cost of success is a matter for allocation among three groups. The producer whose overproduction for known markets tempts him to gamble with highly speculative outlets, is an important part of this picture. The consumer, whose buying habits encourage men and women to start stores on a shoestring, also has his or her figure on this canvas. But the retailer must shoulder the largest share of blame, and

he will continue to do so until he can exact from himself and his colleagues more scientific standards and more professional ethics in the conduct of retail merchandising.

Having gained this leadership in the face of unrestricted competition, the department store can exert it to regain and put into practical effect those functions of advice and guidance which are representative of the retailer's position as purchasing agent for the ultimate consumer in the world markets. The alternative to such activity can only be the passive rôle of a vending machine fed on the one hand by any and all manufacturers and responsive on the other hand to both the needs and the illusions of any and all consumers.

Dismissing such an alternative as hideous, the department store can take intelligent advantage of the obvious fact that no single institution can begin to carry all of the goods now produced. The basic test of saleability can be refined to exclude the specious, no matter how noisy an advertising clamor has been engineered in favor of such goods. Further, this negative power can be coupled with positive action in stimulating manufacturers to produce better goods. The present trend towards more artistic design for articles in every-day use is illustrative of the opportunity for positive action; the establishment of testing laboratories by the more progressive stores and the employment of "stylists" in kitchen utensils and furniture, as well as in gowns and millinery, are indicative of the protective measures of censorship and discrimination.

Again, the store which treats its opportunity seriously and scientifically can exert an important influence on shopping habits. Cash, credit, installment buying and special discounts are matters of basic importance in the distribution of goods and in the best interests of consumers. The extent of free delivery and of selling goods on approval, the provision of lounges and personal shopping service: here are expenses which must be justified before they are incurred. Description of goods advertised for sale can be honestly reported as to both contents and dependability, or it can be "impressionistically" done to stimulate sales. Here is wide scope for developing a fixed policy. High standards, when self-imposed by popular

and successful stores, will be accepted by the more thoughtful type of consumers; and this joining of forces will solidify leadership and will repay most generously the costs of attaining it.

VI

In this gusty atmosphere of problems and opportunities the department store has grown into an American institution. From informal collections of shops straggling along the surface of society and not daring to venture above the second floor, these typical stores have become well-knit and carefully integrated structures which have sunk their foundations into the public's confidence and have reared floor upon floor into popular goodwill. New York is rich in such institutions which have served succeeding generations; but they are by no means exclusive, as national familiarity with outstanding stores in other cities will testify. Each has its own colorful history of growth whether founded by a retired skipper, tired peddler or Irish immigrant. Each was nurtured in the tradition of business as the oldest of the arts. Each which has survived may now regard itself, to quote President Lowell of Harvard, as of the newest of the professions.

Each offers to this generation a fellowship of specialists federated in the common service of buying from the world to sell to a community. Rule of thumb methods are left behind with "store-keeping," for men's thumbs vary in breadth and thickness while the laws of retail distribution in the mass do not deviate. Buying becomes a matter for the trained economist, personnel problems offer a field for the psychiatrist, advertising demands expert training as to both media and methods, control of stock and of finance requires the trained statistician and banker, and leadership of this whole group offers to executive ability opportunities comparable with those created by the great units of mass production.

Thus does the department store emerge from its first short century. It has been a century of the steady replacement of brawn by machinery in mass production, a century which has taken its symbols from the abbreviations for horsepower and

kilowatt hours. Yet the store has stood on personnel, on the progressive training of men and women better to serve those men and women who come to buy. On this basis it offers opportunities for imagination and energy which never will be constrained by the status and functions of a mere vending machine.

XIX

MEAT PACKING

By F. Edson White
President, Armour & Co.

MEAT packing in the United States has developed in marvelous fashion from the farmer packers of colonial times who "packed," that is, cured and smoked, meat for local use during the winter. This is the origin of the word "packer," although to-day only a small part of the meat packing industry is devoted to the production of dried and smoked meats. But the modern meat business would not have attained such great proportions had it not been for its sound beginnings.

During the early nineteenth century a center of meat packing was developing naturally in the middle west. For many years Cincinnati was the best-known pork-packing point and by 1840 had been called "Porkopolis." The reason for its importance was that it was the center of livestock production and occupied a strategic position on river transportation. The production of cattle, hogs and sheep grew rapidly as it was found that this middle-west region was well suited for breeding and feeding livestock. At logical points there were established the great centralized cash livestock markets which have proved fundamental factors in determining the location of packing plants. It was found that the old-fashioned cattle fairs, while picturesque, could not serve the needs of a new era because of the growth of population in cities and the necessity of large-scale markets due to the new facilities of railroad transportation. Hence arose the markets at Chicago, Kansas City, Omaha and other places.

By a most remarkable coincidence there arose, under stress of economic necessity, during the years 1870-75 the four

factors whose combination was essential for the development of the meat industry of to-day. Such factors were: first, the opening and developing of a new source of livestock; second, the extension of railroad transportation to the source of supply; third, refrigeration, and fourth, men to organize the distribution of livestock and meat in a most efficient way.

The new packers appeared between 1865 and 1875. Up to that time meat packers had for the most part been pork packers. But from that time on there came the remarkable development of the dressed beef trade, and the packers with a national market were those who knew cattle dealing or had acquired the knowledge after developing a pork-packing business. Among them were such men as Hammond, Morris, Armour, Swift, and Kingan, who have been called the builders of the modern meat-packing industry, and whose biographies are stirring romances of American business. It was the work of these men with the refrigerator car which revolutionized the meat industry, created the dressed beef traffic on a commercial basis, and organized the distribution system of the modern meat industry. In this task they showed courage seldom equaled in commercial history.

It is impossible to discuss the lives of these men at length, but a few words indicating their significance for the development of this industry are appropriate. It is significant that John Plankinton, the first of these men, began his business at Milwaukee in 1844. By the time of the Civil War, Plankinton had developed one of the largest businesses in the United States. It was during the Civil War that he took P. D. Armour into partnership. The firm of Plankinton and Armour enjoyed a phenomenal growth, and became the most important in the country before 1870. They were chiefly engaged in pork operations and killed beef only for local consumption. Their products were marketed throughout the United States, and they also had a large export business.

Armour saw, however, that the possibilities of Chicago as a livestock center were greater than those of Milwaukee. Consequently, while still a partner with Plankinton, he established a separate plant in Chicago, by forming a partnership with

two of his brothers in 1867. Armour himself did not come to Chicago until 1875. The partnership with Plankinton continued for a number of years, but finally the entire business became consolidated under the name of Armour and Company.

Another of the pioneer packers, Nelson Morris, came to Chicago in 1859. He became one of the largest cattle dealers in the "yards," and built the first packing plant located near the present Union Stock Yards. Morris was responsible for the establishment of the United States export trade in live cattle, and as early as 1868 had made the first successful shipments to England.

Armour and Morris had both been in business in Chicago for a number of years, competing with each other for dominance in the trade, when another of the great pioneers of the packing industry came to Chicago. This was G. F. Swift, who arrived in 1875.

It should be remembered that many others were engaged in meat packing during this period. A few of these men built businesses that endured, but most of them dropped by the wayside because, unlike Armour, Morris and Swift and their associates, they did not keep up with the march of progress in the industry. Several men who were associated with those already mentioned during the seventies and eighties in Chicago later established their own business. Perhaps the most important of these men was Michael Cudahy, a right-hand man in the Armour organization, who founded the Cudahy Packing Company in 1890.

The modern American meat-packing industry draws its raw material from over six million farmers and sells meat and other food products to every person in this country. While it is not the largest industry in the United States, it is exceeded only by the automobile, and iron and steel industry, as indicated by sales. In contrast to other industries, the packing business represents a very different manufacturing process. It takes a fairly compound unit, a steer, hog or sheep, and breaks it down into many parts. In other words, it is a disassembling industry rather than an assembling one, and it is conducted so efficiently that it pays to the producer of the raw materials 85

cents out of each dollar received for finished product. Competition for business is very keen and the perishable nature of the product further augments the risks of the business. Efficient distribution calls for great skill in organization in order to insure an ample and proper supply of meat products in this country and others. A survey of the variations in demand for beef, mutton and pork products indicates the difficulty of the industry very clearly.

For example, the kind of beef or pork most desirable for New England markets does not find a ready sale in the southern States, while beef that is suitable for the Minneapolis trade would not be acceptable in St. Paul. Generally speaking, every community has its individual requirements. Heavy carcasses are in demand in Boston and New England, but the farther south one goes along the eastern seaboard the lighter become the carcasses called for by the trade. The middle west States consume fair to medium grades and seem to demand principally light cattle. This finding of a market for products is more difficult than the slaughtering of live animals and the dressing and shipping of carcasses.

Many people have a rather erroneous idea about our meat consumption. They think that individual meat consumption has been declining and is continuing to decline. This idea is based upon evidence from hotels and indicates that seventy-five years ago we were eating a great deal more meat. It is true that the average American eats about ten pounds less beef and thirteen pounds less pork than his ancestor did in 1830, and a large part of the decrease took place between 1900 and the period of the World War. Since 1917, however, there has been a gain of twenty pounds per person, for while each American ate only 134 pounds of meat in 1917, in 1926 he ate approximately 154 pounds.

The packing industry derives its raw material, of course, from the livestock producers of this country, and in order to understand the development of the packing business it is necessary to make a brief survey of the progress of livestock raising. By the Civil War it was clear that the Middle West was the finest feeding ground for livestock in the world. From 1865

to 1895 there were developed in States further west the great cattle ranges over which a glamour has been cast in song and story. The cattle were driven over the famous trails by cowboys from Texas to Montana, and there was evolved a great surplus supply of cattle ready for the demands of the consuming East which was rapidly growing as an industrial center. The rapid building of railroads, east and west, made it more and more possible to bring live animals to the newly built packing plants, located in a band of territory north and south from St. Paul to the Gulf of Mexico, where they were slaughtered and their products shipped east to feed the population in our large cities.

The modern meat-packing business is carried on in the United States by packers of two kinds:

1. National packers, such as Armour and Company, who are engaged primarily in moving surpluses from the regions of greatest productivity to the regions where local supplies are insufficient to meet needs. National packers must perforce do business on a national scale and they must have numerous branch houses and facilities for conveying their output from their plants to the centers of consumption. Possession of the necessary equipment to do business on a national scale perforce makes a national packer a big packer.

2. Local packers, with a definite trade territory and a more or less fixed clientele. These packers obtain their supplies locally as far as possible and go to terminal markets or the centers of surplus production only when necessary to piece out their needs.

All national packers are subject to government inspection of their product and regulation of their operations. Local packers who do not engage in interstate commerce escape government inspection and supervision.

The large packer came into existence in the United States primarily because of the long distance business that had to be performed. Approximately two-thirds of the livestock is raised west of the Mississippi River and two-thirds of the consumers live east of this river. A very large proportion of the population lives a thousand miles or more distant from the

region where a large percentage of the livestock is produced. This situation requires a vast organization—first, to assemble animals in sufficient quantity and variety; second, to slaughter cattle and dress the resulting beef and preserve it in sanitary manner by refrigeration in coolers until required by consumers; third, to establish and maintain the organization to sell meat in distant markets. This organization in the domestic market requires the operation of branch house, car routes, and special selling organizations, and in the foreign market, branches, agencies, and brokerage arrangements.

The larger packer also has certain advantages from a manufacturing standpoint, such as more complete utilization of by-products, a more minute division of labor, the purchase of supplies in large quantities, and other advantages which accrue to large-scale industry. Additional operating and overhead expenses may largely counterbalance these advantages. It is probably safe to say that the strength of the large packer lies mainly in his ability to sell products in distant markets. In England, where there is fairly uniform distribution of livestock and human population, meat packing is done mainly by a system of small-sized plants that conduct chiefly a local business, because of the small distances from the regions whence they draw their raw material and from the markets in which they sell their products.

Livestock is not sent to market in a steady stream; instead, the flow varies from day to day, week to week, month to month, and season to season. The seasonal variation in the receipts of livestock makes necessary the carrying of certain products from the seasons of heavy marketings to seasons of light marketings. Beef and mutton must be consumed principally while fresh and the task of adjusting cattle slaughter to beef consumption is accomplished without any lengthy cold storage, although refrigeration is a fundamental necessity for carrying on this business. The situation with regard to pork is different in that the cold storage function must be exercised over a longer period. But although the large packer is undoubtedly in a favorable position to equalize distribution by carrying pork products from periods of plenty to periods of

scarcity, it should be recognized that this is, on the whole, at the present time, a supplementary rather than a major function of his large-scale business. A widely known and romantic phase of the packing industry has to do with its utilization of by-products. This is tremendously important because it has added materially to the value of the live animals and it has made their production profitable to farmers when the meat carcasses would not be sufficient in themselves. Due to the splendid work of American chemists, the packing industry has been able to develop means of utilizing nearly all parts of the animals processed in its plant. However, many erroneous ideas are held by the public regarding the meaning of the term by-product. This confusion is added to by the fact that many of the products of the packing industry require elaborate and expensive processing after they leave the packer's hands. Indeed, some of them are but the basis for important outside industries. For example, tanning, glue, gelatin, and animal feed industries are all important businesses, which rely upon packing house by-products for their raw material. The meat packer considers everything a by-product except dressed meat.

It is impossible to give a full list of the by-products of meat packing, but a few illustrations will suffice. Blood is processed in such a way that an edible serum albumen is made and can be used by the bakery trade in almost every case where white of egg is called for. Again, by drying, grinding and screening, a very fine, clean, dark powder, called blood meal, is produced which is widely used as a supplementary food for poultry, calves, colts, and lambs. Dried blood is also used for a fertilizer.

Hoofs and horns are softened by steam, pressed into flat plates, and with the aid of stamping machines are manufactured into combs, buttons, hairpins, umbrella handles, napkin rings, tobacco boxes and buckles. Shin bones are likewise made into knife and razor handles, pipe stems, dice, chess men, electrical bushings, crochet needles, flat buttons, collar buttons, washers, bone rings for nursing bottles, and many other articles. Probably the most important by-product is the hide, which is, of course, subjected to a tanning process and made

into the thousand and one articles of leather which enter into our everyday trade. The hair from cattle and hogs is used as a binder in house plaster, for stuffing horse collars and furniture; and the fine hairs from the ears of cattle are made into hair brushes for fine artistic work. Gall stones are shipped to Japan where they are used as charms to bring good luck. The intestines of livestock are used for sausage casings in general, but certain of the finer grades are cured, dried and used as caps for perfume bottles. Again, intestines from sheep are used for music strings and surgical ligatures.

Among the more recent developments in by-products can be mentioned those used in medicine—the so-called pharmaceuticals. Some fifty preparations are now made from fresh glands and membranes of livestock. Among the important medicinal products are pepsin, pancreatin, thyroids, rennet, benzoinated lard, suprarenalin and pituitary liquid. These are made from glands and membranes of hogs and cows and sheep, and among them are some of the most important therapeutic agents. Recently a cure for diabetes has been developed from the pancreas of hogs which is likely to be of vast benefit to mankind.

Some of the other by-products of the packing industry are soap and glue and gelatin, which are made on a very large scale and whose importance is well known without further discussion.

Packers obtain their livestock in large part through the public livestock markets of which there are over sixty in this country. Of these, Chicago, Kansas City, Omaha, East St. Louis, St. Paul, Fort Worth, Sioux City, St. Joseph, Denver, Wichita, Indianapolis, and Oklahoma City are the most important, and handle about 65 per cent. of the total business. At the markets, all the organizations and facilities for the livestock trade are present, such as a stockyard company, a transportation company, commission houses, packing companies, livestock buyers and speculators, banks and market newspapers.

The stock yard company owns the yards and all the equipment for unloading and sheltering the livestock, also facilities for feeding and watering stock. Its function is really to pro-

vide a hotel for livestock. The company derives its income from the sale of feed and a yardage fee. The transportation company at the market owns the switch tracks leading from the main railroad lines into the yards, and also the engines which handle the livestock trains to and from the loading chutes.

Its service comprises the assembly of the livestock cars from all railroads supplying the market and the delivery to these railroads of outgoing shipments. Its pay is received through switching charges at so much per car.

The commission companies which act as representatives of the sellers are organized in a livestock exchange building. These commission firms have allotted to them by the stock yard company certain groups of pens in the market where they bring the stock consigned to them and offer it for sale. No rent is paid for these pens other than the yardage fee paid by the livestock shipper. The commission firms maintain salesmen who ordinarily specialize in certain classes of livestock, assuring a high degree of efficiency. The grower of the livestock may himself offer his stock for sale, but the custom is to entrust this responsibility to a commission man, who is presumed to have better knowledge of the needs of the various buyers and of market conditions generally. For its service, the commission company is entitled to a fee according to detailed rules. The rates at Chicago are approximately $17 for a straight carload of cattle or calves, and $14 for hogs or sheep in single-deck cars and $20 for double-deck cars. Since the war, coöperative selling organizations have been established which return to the producer owners any profit secured after the cost of service has been paid for.

At all markets, local packers have erected plants from which they supply the neighboring territory with meat. At the big markets, where there is a surplus of livestock in proportion to the local needs, the national packers have located their plants, in which they process livestock, ship the products to all parts of the country, and also abroad, and store other products for the use during seasons of short livestock supply.

Besides the buyers from the local and national packing

houses, so-called order buyers are operating on the market. These men buy mostly on orders for eastern packers, and ship the livestock to the seaboard for slaughter. The traders or speculators buy and sell within the market wherever they expect a chance of profit, and especially buy mixed carloads, sort these and make up new carloads of uniform grades.

Stock yards banks provide facilities for the transactions through commission man and packer which enable the shipper to carry cash home with him if he so desires, or to obtain transfers of credit to his local banking institution. Market papers inform the shipper as to receipts, prices, and trade conditions. In recent years the government has established a service at the larger markets providing regular quotations and other information. The sanitary conditions are also under control of government officials.

When the livestock cars have been switched from the main railroad lines into the yards by the terminal railroad, they are unloaded at the chutes by representatives of the stock yard company who receive the waybills and take over the responsibility for the stock. The animals are brought to the pens of the commission firm to which they are consigned and locked in each pen until the commission firm acknowledges receipt of the stock by requesting the opening of the padlock. For the information of the commission men, the bills of lading are called and posted at the receiving office or chute house. The commission men may also meet the trains and take over their stock from the stock yard company at the chutes.

The commission man orders the feed for the stock and offers the stock for sale. It is customary that only one buyer at a time negotiates with the salesman and the deal is completed by a word or nod of the head, no written contract being prepared. The bidding is on the basis of price per hundred pounds live weight, and immediately after the purchase the stock is driven to the scale houses operated by the stock yard company. The total price determined on the basis of the weight is stamped on the scale ticket. When the stock leaves the scale house, the responsibility of the commission man ends, and the stock is in the possession of the buyer, who ordinarily drives it to

his own pens where he can keep it until it is ready for slaughter or transportation out of the market.

All sales of stock are cash, and the same afternoon on which the stock is sold commission firms make up their accounts with the customers. From the amount actually received for the stock is subtracted the amount of the railroad transportation bill, which the commission man refunds the stock yard company to meet the bill it settled on receipt of cars. Yardage fee, feed bill, insurance fee, and commission fees are also subtracted, as well as occasional special fees for organization work agreed to by the shipper.

The nature of the livestock and meat business, and its relation to the general welfare and health of the people have proved of such importance that governmental services of various sorts have been established. These activities fall under the administration of the U. S. Department of Agriculture, but are conducted by three different institutions—the Bureau of Animal Industry, the Bureau of Agricultural Economics, and the Packers and Stock Yards Administration. The first is responsible for the veterinary inspection at the yards and in the packing plants; the second performs the market news service, and the third administers the regulations dealing with packers and stock yards control.

The Bureau of Animal Industry has charge of the veterinary inspection of livestock and meats. All livestock entering public markets pass by an inspector, all animals suspected of infectious disease being removed and quarantined until they can be killed under special supervision. During the dressing of the carcasses comes a post-mortem examination at which internal organs of the animals are examined for tuberculosis and other diseases which may make them unfit for human food. According to the findings the carcasses are stamped —"U. S. Inspected and Passed," "Passed for Sterilization," or "Condemned." The second group may be sold after proper cooking under government control. The third group is consigned to the grease vat and sold as inedible grease or fertilizer. Also the general hygienic conditions in the packing houses, the treatment of the meats in storage and through

the various processes are supervised by government inspectors who insure the public that all meat products coming from an inspected plant are wholesome and fit for human consumption.

In the wholesale marketing of meat products the backbone of the system is the refrigerator car, first constructed in the seventies and making an epoch in the history of the meat business. Packers for the most part own their refrigerator cars and lease them to railroads on a mileage basis. They in turn pay the railroads the regular freight charges for transporting the meat. The railroads maintain icing stations at intervals of two or three hundred miles along the road and charge the packers for refilling the ice tanks when necessary.

The ideal way of wholesaling meat outside of the immediate neighborhood packing house is through refrigerated branch houses. However, as these require a rather big investment, they can only be established in towns or territories with a population sufficient to develop a considerable volume of trade. The majority of them are, therefore, located in the industrial States of the East, or in the deficient-producing States of the South. A typical branch house includes offices, meat coolers, and frequently equipment for curing and smoking pork products and for making sausages.

Groups of twenty to thirty branch houses are under the direction of a district manager who is the sales director of the territory and also the business manager of the physical properties and equipment, the value of which often amounts to several million dollars. Each branch house is headed by a manager. The branch house has technical help where some processing of meats is performed; in fact, when better prices can be received for freshly packaged or processed products, a part of the ordinary activity of the packing plant is frequently transferred to the branch house. For the sale of packing-house products a staff of salesmen is employed, most of whom do general work, but a few are also specialty salesmen, devoting their efforts to the sales of particular products like canned meats, soap, etc. The salesman solicits orders by calling regularly on customers or by using the telephone. The cost of branch house service

is considerable and amounts on the average to over a dollar per hundredweight of product sold.

In towns or districts where there is not a sufficiently large market to establish a permanent branch house, the trade is covered by car routes. These are either managed from the packing plant at which they start or from the branch house to which they go, after having made intermediate stops enroute. The sales for car routes are made before the car starts by salesmen who travel along the route and solicit orders. The product called for in these orders is then placed in the car in such manner as to make for convenient unloading by the train crew as the car stops at the various places along its route. When orders are insufficient to meet minimum requirements for a car, the balance is made up through the shipment of product that can be taken into stock at some branch house along the line the car is to travel.

Packing houses not having their own branch house systems or wanting to do business in districts where it would not pay them to maintain such houses or send route cars regularly, consign products to local brokers who possess the necessary equipment for handling meat products. The brokers receive regular price quotations from the packers and sell the products on the basis of a commission ranging from 1 to 5 per cent. according to the nature of the product. This way of wholesaling meats is, however, rapidly diminishing in importance.

Certain firms operate on much the same plan as brokers, as the physical distribution of product is concerned, but instead of operating on a commission basis, actually buy and sell goods. Hotel and institutional supply houses come under this class, as do certain large export houses. Jobbers often act as supply agents for a number of retail stores in a given locality, buying the grade and assortment of products they find each retailer needs. Such jobbers usually are limited by their customers in the quantities they buy, but use their own judgment on prices, maintaining their trade by supplying the retailer with meats he can move at a profit.

Foreign demand for certain meat products, mostly from the West Indies, brought about a large export trade from colonial

days on. There was also a great need for meat products to supply the sailing vessels which constituted the sole means of ocean transportation. The early growth of meat packing in the middle west was largely in response to the increasing demand of Europe to feed its growing industrial population. During the latter part of the nineteenth century this country exported vast quantities of beef as well as pork products. But for the past twenty years beef exports have been negligible because other surplus producing countries, for example Argentina, are able to produce beef cheaper than in this country. Furthermore, the United States has developed flourishing industries which, with the growth of population, have created a much greater number of people who are able to consume our meat products here at home. To-day the American export trade in meats has virtually been limited to pork products—bacon, hams, dry salt pork, and lard. In the bacon trade, however, American products are involved in competition from European sources, chiefly Denmark. Even with the natural decline of our export trade in meat products, the United States exports about 20 per cent. of the meats and animal fats which enter into international trade.

The high point of our export trade in meats was during the war and immediately after it, when in a dramatic way, American food products saved Europe from what might have been the worst famine since the Thirty Years' War. The magnitude of the effort put forth by American packers can be seen by noting exports during the pre-war and war period. For the three years preceding the war the monthly average of exports was a little over 1,000,000 pounds. In June, 1918, the beef exports were 92,000,000 pounds. The monthly average of pork product exports for the three years before the war was 41,500,000 pounds, while in June, 1918, they were 170,000,000 pounds.

The war needs brought problems in manufacturing of canned and cured meats which were stupendous. Speed made necessary wherever possible the substitution of machine work for hand operations. The center of activity was Chicago, although all meat packers throughout the country were also

busy at top speed. In one canning plant five thousand people were employed and some two thousand cattle a day went into some various sorts of canned goods. The increase in the number of workers was from 100 to 200 per cent. in a year. Perhaps no other industry has witnessed such a concentration of appliances and workers in the same number of square feet. One of the most popular products was corn beef hash where production increased 100 per cent. in one year, a single company making 187,000 pounds of it in a day.

One of the biggest of the packers' problems was to get the products to Atlantic ports on time and have the dressed and canned and cured meats loaded on the steamships without delay and deterioration. This was most difficult, for ships often arrived without advance notice because of the danger of sending wireless messages. The instant that a ship came in, therefore, the machinery of the whole distribution system of the packing industry began to function with extraordinary speed. It was in preparation for just such emergencies that immense supplies of meat and meat products were kept in reserve in the refrigerator rooms. In its curing cellars one big concern averaged one hundred million pounds of meats in various states of preparation.

The importance of having a well-articulated national system of distribution was clearly shown. When one of these rush orders came, hundreds of men were shifted from other departments and set to work handling and loading the products required. In filling one rush order a Chicago packing company in one week shipped one thousand carloads, two-thirds for the allied nations, which amounted altogether to some thirty-two million pounds of meat products. Of these, twenty million pounds were fresh and frozen beef cuts, eight million pounds of cured pork products, bacon and ham, three million five hundred thousand pounds of lard and oils, and seven hundred and thirty thousand pounds of other products. The same company averaged weekly shipments of twenty to twenty-five million pounds and on one occasion, when it was necessary to utilize steamer space in a hurry, twenty-four million pounds of meats and fats were shipped from Chicago on three days' notice.

It is curious that the general public did not realize the real scope of the work that the packers were doing to help win the war. Most people know, of course, that the packers furnished meat and meat food products, but not one in a hundred had any idea that the packing industry went further than that. For example, the industry furnished a great deal of material for the manufacture of munitions, including glycerin, potash, and sulphuric acid. Besides this, sheep skins were used to manufacture cold-proof coats. Every pound of wool was taken by the government as fast as the packers could produce it, and at a price fixed by the government. All the stock feed made by the packers went to put weight on livestock which were later food for the troops. The tons of fertilizer which the packers turned out aided in the growing of more crops. Glue also had its uses. Soap was a big item. Albumen was another highly important product used in the construction of aeroplanes. These were but a few of the ways in which the packing industry did remarkably important war service.

The meat packing industry's contribution did not cease with the shipping of meat products from America. It was employees of the meat packing industry, as was stated in *Le Matin,* who constructed the huge army refrigerating plant in central France. That plant covered several acres and had a capacity of 10,400,000 pounds of meat, which is the equivalent of 15,000 head of cattle weighing an average of 700 pounds a piece. In addition to the necessary plant refrigeration it had facilities to turn out daily 500 additional tons of ice for icing refrigerator cars. The Parisian paper declared this a most striking and characteristic example of American genius and energy. In this the American packing industry was the means of proof of Napoleon's famous dictum regarding the winning of a war, "An army travels on its stomach."

During the past, charges of monopoly and of unlawful agreements in the meat-packing industry have been the subject of considerable public discussion and semi-political agitation. Naturally, such charges have a strong public appeal. Farmers, ranchers and feeders of livestock are deeply interested in having the packers pay more for their animals. On the other

hand, the great consuming public is interested in securing lower prices for meats and meat food products. The result has been that a fair and impartial consideration of the many charges against the packers has been almost impossible.

Generally, the charge of unlawful agreements among the packers has been based on the fact that the percentage of livestock receipts purchased by each of the larger packers remains approximately constant from year to year. Such was the principal charge in the case brought against the packers in 1912 which, incidentally, was the only suit ever brought to a final conclusion wherein the packers were given a trial and an opportunity to defend themselves. In that case, the packers' defense against such charge was that each packing concern is constantly endeavoring to increase its volume of purchases and is, in turn, met by an equally strong effort on the part of every other packer to hold and increase his own volume of purchases. The result of this constant competition is that no single packer is able to increase to an appreciable extent his proportionate purchase of livestock. That such is in fact the situation was accepted by the jury trying the case against the packers in 1912 since, after months of strenuous effort on the part of the government to prove their case, the jury returned a verdict of "not guilty."

The final investigation of the packers was carried on by the Federal Trade Commission which began its work in 1917. Such investigation was wholly *ex parte* and the packers were never given an opportunity to meet and refute the many charges made public by the Trade Commission's representatives. In the report finally made by the Trade Commission, the five larger packers were again charged with violation of the anti-trust laws and some forty cases were instituted by the Commission against such packers. All of these cases against Armour and Company, after trial and hearing thereof, were afterward dismissed by the Federal Trade Commission itself and, with one exception, all like cases instituted against the other larger packers were dismissed.

At the time of the Trade Commission's investigation and report on the meat packing industry, public opinion was greatly

stirred owing to the high cost of living brought about by war conditions. The effect of the Commission's report upon the packing business was distinctly harmful, both at home and abroad, and caused a great deal of unfair and unjust criticism of the packers.

It was at this time that the larger packers entered into the so-called Consent Decree, which provided that they should dispose of their interests in public stockyards, stockyard terminals and railroads, market papers, cold storage warehouses, and give up the sale of "unrelated lines" and the use of their distributive system for other than meat products. They entered into this decree, however, only upon the express condition embodied in the decree itself "that their consents to the entry of said decree shall not constitute or be considered an admission, and the rendition or entry of said decree, or the decree itself, shall not constitute or be considered an adjudication that the defendants or any of them have in fact violated any law of the United States."

In the meantime, a number of bills for regulating the meat packing industry were introduced in Congress, and, finally, the Packers and Stockyards Act 1921 was passed, whereby the packers are placed under the jurisdiction of the Secretary of Agriculture and provision made for full investigation and determination by him of all charges of illegal practices by packers. It is believed that this law and its fair and impartial administration by the Department of Agriculture have been distinctly helpful. The first few years' record of the administration of this law has been one of constructive coöperation between the packers and the Department of Agriculture, and of progress in solving the many difficulties of this great industry. Since the passage of this act, the semi-political agitation against the packers and charges of lack of competition in the industry have been reduced to a minimum.

The public conception of the extent of competition and its keenness within the packing industry has been fashioned very largely by critics. On the other hand, little has been provided by its representatives to crystallize a clear picture of the conditions which actually exist. The popular view of current eco-

nomic affairs is determined largely by the sensational generalizations which find expression in the press. These expressions, however, are usually based on the charges made by individuals or organizations which are assumed to be competent, but which usually prove to be superficial and erroneous. It has been possible for confused viewpoints to be accepted as true, because of the great complexity of the business, the variety of services required of the industry, and the apparently indirect functioning of the law of supply and demand, since the consumer demand is not expressed for livestock (in which form the supply is secured), but for meat, fats, hides, and animal by-products.

That substantial competition exists between the various packers was definitely determined by the Secretary of Agriculture in his decision in the so-called Armour-Morris merger case. In that case scores of witnesses consisting of livestock producers and feeders, commission men, wholesale and retail meat dealers and packers gave their testimony at hearings which were held at Denver, Kansas City, Chicago, St. Louis, New York and Washington. The Secretary's final decision was that competition in the handling and sale of meat and meat food products had been keen and active, and that furthermore, the evidence in the case showed "that during the last decade both the number of independent packers of substantial size and the volume of business done by them have largely increased."

The fundamental difficulty in understanding the competitive situation among meat packers has arisen from the different services required in the marketing of livestock and in filling the wants of consumers. All sections of the United States consume some meat, and all sections produce some livestock. However, in the industrial regions the demand far outweighs the supply, and in the producing regions the supply similarly outweighs the demand. This situation provides a logical background for the location of the plants of the local packer in the regions of light supply and large demand, and for the plants of the national packer, dealing in surpluses, in the regions of heavy supply and lighter demand.

The local packer can compete against the national packer because he deals in quicker turnovers, possesses more uniform outlets, distributes his products over narrower areas with lighter transportation costs, and requires less overhead expense in operating. These factors permit him to reduce operations in the face of unfavorable markets and to operate heavily when his livestock is cutting out a profit. The big packer, on the other hand, has the advantage of wider distributive outlets, more perfect utilization of by-products, and sufficient storage capacity to permit more uniform sales throughout the year. This comparative situation between the two types of packers has brought about the keenest degree of competitive conditions within the industry.

Some producers have believed that the packer can or does manipulate the market. This belief has been based largely on the lack of adequate demand when there have been heavy gluts in the runs of livestock, or on the supposed desire of the packer to break the prices of livestock to constantly lower levels. Both of these conditions are merely apparent and have very natural explanations. When heavy runs of livestock occur, the channels of trade in meat and meat products become choked and the packer who buys beyond his requirements incurs a tremendous marketing risk. If he does purchase an additional number of head, he must do so at a price commensurate with the risk he is assuming. This risk, however, is not confined to the actual value of the animals he purchases, but includes the extreme probability of a break in the entire market for meats and a reduction in the price level on everything which he and his competitors may previously have purchased. In the case of a small packer, the financial risk, of course, is not great, but in the case of a packer with broad interests the problem is vital. Under any circumstances, this produces a unity of interest that gives an appearance of predetermined action to the disappointed seller.

However, it is gratifying to note that in recent years there has developed a more intelligent understanding of the economics of the packing industry on the part of the American public. The financial difficulties of the post-war period, the

realization of the narrow margin of profits on which the meat industry operates in return for the extraordinary risks inherent in the nature of the business, and the era of reasonableness and appreciation of the public service aspects of large business units, have all contributed to a good feeling, on the one hand, between packers and producers, and packers and consumers on the other. The maintenance of such a spirit of coöperation in the future means benefits alike to the various elements in the livestock and packing industries and to all the consumers of the products of packing plants throughout the United States and the rest of the world.

XX

BUILDING CONSTRUCTION

By Hugh White
Chairman of the Board, George A. Fuller Co.

THE history of building is a record of the times, rather than a subject of analytical description. The products of individual ages, particularly as evidenced in the crafts of the builders, are probably the most enduring and reliable sources of material for the historian.

Building progress during the past hundred years is written on every side in wood, stone, concrete and other predominating materials of the various building eras. There are standing a great number of buildings erected in the period between 1828 and 1928, and in our own country the older structures form an almost infinitesimal fraction of the vast number that industrial and social progress has necessitated during the past few decades.

The contrast between the older buildings and the newer is usually only brought into relief when something of a sensational nature, like a sweeping revision of housing regulations or a disastrous fire, brings their modern inadequacy to mind. The newer buildings of course command our closest attention as they attain greater and greater heights, although the engineering development which has made the skyscraper possible is only one phase of building progress. In comfort, sanitation, light and air, and a thousand other conveniences which are the products of the past hundred years, the present building, of however unimposing a type architecturally, far excels the most luxurious palace that was ever built for a Doge of Venice or a Louis XIV.

Nor are buildings, even of comparable grandeur, built to-day

with the sacrifice of the health and lives of the workers, or by the lash-driven toil of men from the prisons, or the galleys, or even from poor districts where the scarcity of the bare necessities of life made necessary their unregarded labor at long hours and poor pay. All these conditions have been finally and definitely abolished only within the past hundred years, and they form a rare contrast with conditions of to-day, when the workers, under vastly different conditions, are building modern structures which they themselves, or others earning about the same wage, will later occupy as homes. The newer apartment houses for the working classes are excellently planned buildings, the difference between which and the more expensive apartment dwellings probably only consists of room size, and the extent of the ornamentation and the less important luxurious appointments.

We probably cannot realize to the full extent just how building construction has kept pace with the expanding needs of great industrial changes, and how, with almost the quality of fluidity, buildings have grown up and around the things and the people who dictate their shapes, and have accommodated themselves to the demands imposed by the expansion of public education with its growing consciousness of the better things of living.

Every phase of social evolution—and the past hundred years have excelled all others in this respect—has brought its own requirements of better housing for people at work and at home.

This same parallel progress of public social education and housing is of course served mutually in that the education which teaches us to demand better buildings also tells us how to build them, and in that education is largely made possible through the availability of modern buildings at costs within the reach of communities or the other enterprises which support institutions of learning.

The far-reaching requirements of sanitation, electric lighting, central heating, and hygienic provision for light and air which education has largely brought about have been met by mechanical perfection of equipment which are the more won-

derful because of their availability at low cost. We call upon a hundred specialists in the various branches of building to-day whereas, in times past, the individual craftsman did practically every type of the work connected with building, the only differentiation usually being in that of the major trades, carpentry and masonry.

Another result of the social reform, so far as actual building construction is concerned, is made manifest in the numerous safeguards which surround the worker to-day against the hazards of accident. Where, formerly, low wages drove the worker to his task in a position which might, through the careless attitude of an indifferent employer, court injury or death, he is now equipped with the most highly improved devices for preventing accident to himself or his coworker. Openings are temporarily barricaded; scaffolds are supported by steel cables and special winches, and the factor of safety in any machine which might otherwise imperil the workers is made extremely high.

If in spite of these safeguards the worker is injured, compensation insurance or legal redress through laws which have been framed to protect him will, so far as money and skilled medical attendance are able, ameliorate any distress that he or his family might suffer.

This close connection between the social and political aspects of building and of the everyday life of the people would almost seem to make the history of building the history of its age. With the dawning of the industrial era, probably most strongly betokened in England a little more than a century ago, the first demands for office buildings and commercial structures, banks and great business houses, began that development of the modern methods of building which have reached that point in development which produces to-day's skyscrapers.

For the first time, great numbers of people were concentrated at their daily tasks in central manufacturing establishments. Articles of commerce, textiles, even foods were starting to become the product of the factory, and the day when the husbandman and the housewife produced their own necessities began to decline.

With this same concentration of great masses of people at their daily work came also the first building on any large scale of the community dwelling, the apartment house of our cities, the flat building of the English. The first of these were probably far worse, from the hygienic standpoint, than the old-law tenements which are the central feature of municipal reform discussions in New York at the present time; we are familiar, from descriptions in Dickens' works, with the slum conditions in London of a hundred years ago. It seems a far cry to the modern American apartment buildings, which good design, steel, modern invention and far-seeing legislation are making veritable palaces of habitation, beside which even the nobles' castles of a former time seem pitiably barren and comfortless.

Structurally, however, the modern building of steel is much less than a hundred years old. The first modern steel-framed building was erected in Chicago in 1885 by W. J. B. Jenney and George A. Fuller; it was the precursor of thousands which have followed this new method of construction, which, in conjunction with the development of the elevator, in one motion swept away the structural limitations and the restrictions which had hampered even the genius of the classical architects, but which fell before the vital demands of a new era of thought and action in building.

The main structural limitation theretofore had been the load-carrying capacity, and the thickness of the enclosing walls, which features fixed the economical height to which a structure could be built, but which condition has been eliminated almost universally by the skeleton steel frame in large building work. Curtain or panel walls are now supported at each story of these immense buildings on spandrel beams, these in turn being anchored to the tough, immensely strong steel columns which are the bone structure of the building.

In the place of the heavy and set feeling which the old and squat buildings engendered in the mind of the onlooker, we now have, from an architectural standpoint, the flexible vital upspringing of the steel frame in its light sheath of masonry.

The scientifically calculated loads of the building are now

transmitted down through a system of steel columns to the ground footings, instead of an almost total concentration of the weight on the exterior walls.

Before the advent of steel, the builders and architects of the new and the old worlds had experimented with cast iron, with wrought iron, and with combinations of the two with wood, the object being to secure freedom from the limiting effect of the load-bearing wall. The first real use of iron was in the English factory building. Here considerable headway was gained by the use of iron floor beams, the spaces between filled by brick arches. The defect of this type of construction came after it had been heralded as fireproof. Most of the interior fittings of buildings of that period were of wood, and several serious fires taught that cast iron beams, heated to a high degree by an internal fire, would crack or deflect and allow the floors to collapse when struck by the stream of water from the fire hose.

Nevertheless, this method of the then supposedly advanced construction gained great headway, and there are still extant buildings in England which were framed in this manner; many of these, however, of a somewhat later date attempted to partially fireproof the iron by crudely covering it with brickwork or clay materials.

Wrought-iron floor beams, crudely fabricated with webs and flanges hand welded and riveted, next made their appearance, and their superior strength over the naturally brittle qualities of the cast product gained many adherents. Their costliness, however, was the chief factor which, combined with unfamiliarity on the part of most artisans, prevented their very wide or general adoption.

The age of the steel building dawned some time after the commercial use of large steel products was made possible by the development of steel itself. This came with the invention of the Bessemer process and the development of the open hearth process for producing steel. Once started, however, the change-over in building methods was quick and revolutionary in its scope. After that first all-steel-framed building, called the Tacoma Building, at Madison and Clark streets in

Chicago, the technique of rapid erection with steel was taken up by the foremost engineering minds. Hitherto unattainable and unthought-of heights were reached, the various branches of the profession of building the modern structure became more diversified and more sharply defined, and the age of steel was under way.

Concurrently with the perfection of skeleton steel construction progressed the development of the second great factor in modern building. This is the reënforced concrete building, which is literally poured into place as liquid concrete, between temporary wooden or steel forms. Every inherent advantage of the flexibility of that material is thus utilized to high degree, and even the detail ornamentation of such a building is usually of concrete, although many of the individual pieces may be cast at a distance from the job and set into place during the finishing operations on the structure.

The reënforcement of the flat-slab type of building is by steel, usually in the form of rods and mesh fabric. Twisted and "deformed" steel bars go into the heavier supporting pieces of poured masonry, while the floors are constructed by casting comparatively thin slabs of concrete over and around areas of steel mesh and smaller rods.

The chief use of flat slab construction is in buildings where great height is not the desired end. Factories, warehouses, piers, and like structures are more and more being built by this method as one of the most economical and one of the most effective means of providing a fireproof and permanent building. The method has, too, a beauty of its own, as there is a certain moldable, flexible quality about poured concrete above and beyond its perfect adaptability to architectural creations derived from the classic conceptions which governed masonry construction.

The steel-framed and the flat slab building, then, are the two chief contributions of modern building to industrial progress to-day. Their significance is wide and deep, their potentialities boundless.

To industry it has meant that steel and concrete, both materials having the quality of adaptability in high degree, can

follow closely and supply the always changing requirements of new mechanical conditions in manufacture.

To architecture it has meant that the connoisseur and the man who relies upon his sensibilities as to what is fitting, may ignore the isms, the schools, and realize that proper embellishment of the building takes account of its individuality and accentuates the grace of its structural lines and its planes, not seeking to conceal the strength which underlies the surface, or the lines of that strength.

For centuries past, the function of architecture was to embellish rather than to conceal the structural features, but the first work with steel was unfortunate in this respect, probably because steel gave so much freedom of placement. The first decorative treatments were simply imitations of architectural embellishment which had been rigidly dictated by the structural lines of the old buildings. This condition led, for a while, to a chaotic scrambling of architectural styles, and brought about purely "decorative" architecture, without reference to structural demands, and therefore, practically speaking, without honesty of purpose. It merely sought to make decorative, in some way or any way, certain masses of the building which seemed to require ornamentation.

The past ten years or so, however, has witnessed a return to the old forthrightness of principle in design. The skyscraper and the modern building of to-day is almost invariably embellished in motifs of its own, usually of the steel vertical columns which are its structural support.

Steel has brought a great new age for architecture, just as the arch, the pendentive, or the flying buttress brought new forms and new conceptions into being. But modern steel buildings have a quality more inspiring to architecture than these old inventions with their limited scope. Steel has flexibility and life, and the buildings which it frames seem to have a fine exaltation in their cloud-piercing reach.

They express definitely the activity which goes on within their walls: the darting movements of the elevators within is seemingly caught in the pulsating vertical rhythm of tier on tier of windows.

The details of the science of mechanical equipment which was forced to keep pace with the growing demands of the vaulting building heights are now in themselves a vast and complex study. Supplying the modern skyscraper with the industrial and personal necessities of its thousands of inhabitants is a scientific undertaking, and calls for the highest exercise of a group of related talents.

The modern elevator, as an instance, is, in its finished and perfected state, a complex and highly developed mechanism which employs abstruse electrical and magnetic principles in its design. Speeds of 500 to 700 and more feet per minute are now common, while such features as the micro-drive, the unit multi-voltage control and the signal control have given us the efficiency and smoothness in operation which have come to be accepted as commonplace, although they would have been regarded with awe but twenty years ago.

The electrical and sanitary requirements of the modern large building, often of a capacity which would equal that of a fair-sized town, are also complete studies in themselves. Particularly so when it is remembered that the population of this building, unlike that of the city or town, moves in and moves out again eight hours later with clock-like regularity.

Provision must be made for supplying these people on every floor with thousands of gallons of hot and cold water, with electricity for lighting and operating the numberless household and office appliances, for insuring that there will be individual telephone connections, and for changing partitions and other stable fixtures as old tenants move out and new ones move in.

The first standpipe system is rigidly defined in its requirements by the codes of most municipalities and must form in itself a complete fire-fighting system, the capacity of which can be increased tenfold by connections made with the fire apparatus of the city.

Vacuum cleaner lines must penetrate the entire building and be connected with an elaborate suction apparatus in the basement.

The entrance halls and corridors of the latest skyscrapers call upon the best work of the artist for their planning and execu-

tion. Elaborate mosaics and works in tile, faithful reproductions of the greatest works of antiquity and the best modern work, ornament the great and stately halls which give a seemly dignity to the modern structure's immensity. Of late, a new mode in these decorations has come into wide favor, both because of its genuine artistic worth and its comparatively low expense. This gains a large degree of the sought-for artistry of texture and detail with the new plastic paints and synthetic compounds which are worked to resemble Travertine, Caen, and the other costly stones used to cover wide corridor expanses.

Extruded brass and bronze are branches of the metal worker's art which have received great impetus in development during the past few years because of their wide use in office and bank structures. We still call upon the four corners of the earth to supply tapestries, stones, tile, mosaic, paintings and rare metal work, but the craftsmen of our own country are more and more evolving products of equal or superior beauty and worth.

With this demand for more and varied products has come a change in the methods of personnel organization which nowadays must gather together the members of many professions to plan and execute an undertaking like the erection of a modern skyscraper. The organization calls into its folds the engineer, the banker, the lawyer, the architect, and a score of assistants, before even tentative plans may be drawn for a new building. The financial and legal end of things is outside our province in this story, but the work of the engineer who must be closely associated all through the work with the architect requires some word of explanation.

Engineer and architect must closely coöperate to-day because of the almost wholly technical nature of modern building methods. Each phase of construction, from the planning for excavation to the decision upon roofing types, calls for the combination of engineering and architectural faculties as represented in highly trained individuals, and specialization is increasing year by year the variety and the number of the experts involved in a large operation.

Foundation work is a large branch of engineering in itself and is usually only entrusted to men who have had wide practical experience and technical education of a high type. The immense loads which tall buildings represent, particularly in the case of the skyscrapers which are the peaks in our mountain range-like skylines, impose a terrific responsibility upon the foundation engineer. He must be something of a geologist as well as a scientist to carry on his exacting work.

In this light, it must be remembered that there is a certain factor of movement in the flexible steel frame of the buildings he is called upon to support. This must be taken into account, as well as the possibility of earth tremors in certain localities. The modern building can withstand a high degree of side movement or swaying caused by wind, but a vertical move even so slight as one inch would shatter the structure. Nothing on earth could withstand the sudden shock of bringing to a stop this vertical movement, though its entire range might be measured in fractions of an inch.

The foundation engineer has many and various factors to contend with in his chief job, which is to reach down his foundations to a stratum of earth or rock which will safely support the structure to be built. Test borings and a general knowledge of local conditions usually determine the method of resting the foundation, whether on bed rock directly, by sinking caissons to bedrock, on piling of various types, or on earth by means of ordinary spread footings.

With the actual work of digging and blasting the foundations there is the work of devising and installing the shoring system which must support adjoining buildings or streets against collapse. This usually calls for an intricate maze of heavy timbers and steel beams, increasing in its complexity as the work progresses and always safeguarding the workers and equipment as they dig deeper and deeper. Surface and subsoil drainage must be provided; the sudden deluge of the unexpected storm must be guarded against.

The principle of piling is an old one and probably familiar to most, but the pneumatic caisson is altogether modern in that it has been developed to meet conditions brought about by

economic pressure, forcing men to build large structures where the architects of the old days would have hesitated to place even small buildings.

The caisson consists of a hollow concrete working chamber, bottomless, but with a steel cutting edge which presses down as the workmen inside excavate from beneath it. It is entered from the top by a collapsible steel shaft equipped with air locks and a hoist for men and materials. The reënforced concrete of the foundation is poured around the collapsible shaft and its weight forces the caisson down as material is removed from beneath. The material is passed up through the air locks, which confine the compressed air used to keep subsoil water and unstable material out of the working chamber.

When the caisson reaches bedrock, it is filled with concrete and becomes the footing of the column which has been built up surmounting it. The steel shaft is collapsed and withdrawn and concrete poured into its place, making a monolithic job.

After the foundation work comes the steel skeleton, usually designed months in advance of the time when the individual pieces start coming from the steel mill at some far-away mining center. In this way, practically the entire framework of the building is made at a distance from the building, the steel workers assembling the individual columns, girders and beams as they arrive at the job in proper order. Naturally, a complicated system of numbering these individual pieces must be utilized to prevent confusion, and this also requires careful routing in transit to insure that the entire building will not be held up pending the arrival of some important structural member.

Derricks, their platforms progressively raised as each floor is completed, lift the steel into place, where it is temporarily bolted through holes nicely and accurately punched at the mill until their final riveting, or, in some cases, welding.

The fireproof floor and roof construction comprises the third of the three elemental divisions of the modern building operation. The function of the floor construction, with the roof and the exterior curtain walls, is as much to protect the

steel frame against fire as it is to provide actual support or enclosure, and it has been the subject of intense scientific research to this end.

There are two general types of fireproof floor construction, generally termed the long span and short span systems. Their use is usually determined by the local availability of various materials and their relative cost; the long span system, using less supporting steel work but more of concrete and other materials, which, if high in price, may determine the use of the short span system, with its greater reliance on steel.

The short span system is, as the term indicates, one in which the distance between supporting members of steel is relatively small, rarely more than eight feet. The spaces between, of course, must be filled with an incombustible material, of which terra cotta tile, reënforced concrete, poured gypsum, pre-cast gypsum and the now almost obsolete brick arch form the types in most general use. The choice of this material is usually dictated by local or special conditions, and many cities have extremely stringent laws regarding its proper constituency and application.

The long span system employs fewer steel floor joints and the required strength for the floor sections is gained by casting concrete, suitably reënforced, in shapes which give it the necessary inherent strength. Segmental arches of terra cotta and other materials are used alone or in combination with concrete, and special types of floor construction employing metal floor pans and patented forms are usually dictated by special local conditions.

There have recently been developed many types of light weight steel construction for the erection of the less expensive type of buildings for "light occupancy." These employ light rolled and pressed sections of steel, or open work fabricated members as joists, and these are fast replacing wood construction, as it has been found that they can be used at even less cost.

The enclosure of the building is the last step in its completion and most generally is by comparatively thin walls of brick, supported at every story on beams attached to the outside face

of the outer steel columns. Thus a direct reversal of building practice has been accomplished, and the building now supports the walls, where formerly the walls supported the building.

These various operations have each called into being a host of labor-saving equipment, which removes from the workers the direct burden of much of the work and entrusts them with a good deal of directional responsibility. It has made the individual worker a much more productive unit, and seemingly has not had the effect of cutting down employment, as the steadily mounting wage scales of the past few years will attest.

The question of whether or not the mechanical facilities applied to a building operation have injured or helped the spirit of craftsmanship is always a debated point, but it would appear to be true that those operations requiring individual skill are now performed with greater skill than ever before, due to the increase of the volume of construction, while those operations which do not require skill and are performed with mechanical means are automatically maintained at the necessary standard if proper supervision is maintained.

It is interesting to know that architecture now recognizes no height limitation excepting that of economic construction. The economic point in construction is that which is passed when the cross-sectional area of the lower floors of the building is disproportionately occupied by service and mechanical facilities required for the upper floors.

That if elevators, immense pipes, and the necessary electrical, telephone, vacuum cleaning and other conduits occupy a great deal of the valuable space on the first floors, the advantages of the higher spaces are to a great extent nullified and the very immensity of the building may cause it to fail in bringing a suitable return on the investment.

Nevertheless, even greater buildings are being planned, and now there are several great underlying influences being taken into account in their planning. The city authorities now realize the immense demands placed upon transit facilities, upon water supply and upon street traffic by these great buildings, and future city plans will provide for their requirements. Changing conditions of transport, including the coming of air travel,

will doubtless make necessary extensive changes in buildings, including provision for accommodating planes or dirigibles on roof tops.

But the flexibility of steel and concrete, their adaptability to any and all conditions, will probably go far to simplify these changes when they do come, and will make possible architectural marvels beside which even the immense buildings of our own age will seem small and inadequate.

Architecture itself must inevitably gain in the vitality which close association with the active life of a people means. There can be no stagnation in building when industrial trends bring it into ever closer relation to the lives of millions who inhabit large buildings or who earn their livelihood in them. This intimate connection between building and the lives of all the people is always tending to increase with greater concentration in cities and the social and industrial trends going forward with this concentration.

Ascetic and austere as may be the underlying art forms which control the design of the modern building it is now produced for a public need, with much closer relation to a people than the motives which inspired the great architectures of former times, so largely ecclesiastical as they were.

The personalities of the new era in building are a roster of names which include the greatest talent which the new world has produced. Engineers, architects and great financiers are those who have given us new forms and new principles to conjure with in seeking to lift the veil of future building.

XXI

LABOR AND AMERICA'S CENTURY OF INDUSTRY

By William Green
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THE fundamental fact of Labor's development in the past century of American industry is the interdependence of the progress of Labor upon all the other factors of industrial life and development. There are always employers and employed and a technical procedure but no one element can prosper alone and no one factor can make progress alone.

Industry itself is a bringing together of materials and forces in order that a definite purpose may be marked out and in the doing of that definite thing all in industry bring together their various capacities. This fact of associated endeavor is a principle that industrial organizers whether Labor or management should make basic in all their planning.

The sacredness of Labor is an idea that is century-old. As men divined the creative character of Labor they sensed its relationship to the spiritual capacities of mankind and found in it possibilities of unfoldment of mind and spirit that constitute human growth in all its phases. Work is of the fullness of life and the work of any one group of a nation's citizenry is a determining part of its history and progress. So this past century of American industry is interwoven in our nation's history conditioned by environment and all the social factors that condition development and guided by the genius and purpose of the human personalities that participated in the various undertakings.

As we find the beginnings of American industry were local

and very simply organized, so we also find the beginnings of organization among laborers. Simple hand industries necessarily defined, developed craft skill and it was necessary that those coming into the craft should have adequate training. To serve this primary function was a purpose of the early American unions. The union has continued to be the repository of work-skill and work experience. This is a profoundly significant fact, disclosing as it does the educational origin and purpose of organization among wage-earners. To realize the ideals embodied in this purpose, organizations of workers must have effectiveness of achievement and power to sustain achievement.

Because in the early period of American industry communities were widely separated and intercourse difficult, industries were local developments to meet local needs, organizations of workers were also local and concerned only with achieving their purposes for the workers of the single community, or even a particular craft in that community. It was only as industry and the basis of social life became more complex and interrelated that the same qualities were reflected in organizations of workers in industry.

As craft unions grew in strength and attempted to establish increasingly higher ideals and conditions for wage-earners they had to combat restrictive ideas inherited from English thought in which American civilization had its life springs. As we know life through its tangible, material manifestations, so the basic program of progress which unions seek to realize ever concerns itself with the material means for opportunities for more abundant life—increased purchasing power for wage-earners and a regulation of the work period so there might be opportunity for social development and that work itself might not be degraded into mere toil. Hand industry and inadequate lighting fixed early work hours by the sun. The pioneer custom of approximate self-sufficiency of each family and each community contributed to low wage standards. In order that wage-earners might participate in the social changes and progress of the country there had to be a constructive agency to take care of their interests and thus to enable them

to keep pace with national development. Not only is such an agency a benefit to those directly concerned, but it is most essential to the best interests of all industrial groups and of the nation itself that no one group lag far behind others. However, men are often slow to recognize progress in change and early efforts of American unions to raise wages and shorten hours were opposed economically and carried into courts by employers for damages against "conspiracy" on the part of workers. Under English common law an aggressive effort of wage-earners to raise wages was then regarded as a conspiracy not only against the employer but against the public. The unions set themselves to the task of getting both the judiciary and the legislatures to think of them as constructive and legal agencies and finally succeeded in getting recognized as legal organizations. But the anti-conspiracy law enacted decided only the issue of the legality of the union and left its activities still questioned by courts. The battle to legalize the union in fact as well as in theory continues to-day.

The early unions shortly emphasized control of apprentice training. Standards of craftsmanship were necessary to good work and without good workmanship high wages could not be maintained. Hence the union sought to maintain control both over those coming into the trade and over all employed. The first purposes for which American Labor turned from the economic field to secure political action were laws to regulate hours of work and free public schools. With widening conceptions of democracy in the states, Labor became conscious of two needs—the ballot and education. The chasm created by differences in educational opportunities is perhaps the most difficult of all to bridge. What free schools there were fixed a stigma of poverty upon those unable to pay fees. Wage-earners wanted to free their children from such bonds of class differences and it was definitely through the support and initiative of wage-earners that campaigns for free public schools reached successful legislative results. The influence of free educational opportunities for all is immeasurable in the social development of our nation. Rested upon a better educated electorate, manhood suffrage became an institution

of value. Free public schools and a widening of the basis for suffrage progressed largely through the purposeful activity of Labor. Some progress was made in regulating hours of work by state legislation, but experiences with enforcement and application were discouraging. Decisions of the judiciary helped to strengthen American Labor's inclination to employ economic means. In this inclination Labor reflected a national characteristic growing out of conditions of environment. Voluntary methods and individual initiative were methods indispensable to pioneer needs and frontier relationships. With commensurate opportunities for personal independence American wage-earners responded and there developed for Labor that same flexibility that distinguishes our national life as a whole. It is a flexibility that has prevented the crystallization of fixed classes and freely makes possible service according to capacity. It has more recently made possible agreements under which workers and management coöperate in the promotion of mutual interests.

In the first half of the nineteenth century, union development moved along slowly, reflecting the gradual widening of industrial organization and its technical changes together with the integrating influence of improvements in transportation and communication. Financial fortunes of business are directly reflected in the fluctuations in union strength and activity. Business crises in that period were fairly frequent and sorely tested the resources of the new unions but the virility due to performance of a vital function enabled the unions to survive the most severe upheavals. Immediately preceding the Civil War came efforts to unite local craft unions upon an industrial or national basis. Unions were among the first to realize industry had a continental as well as a national basis but full realization of this fact waited upon the development of modern transportation and communication.

The first general united efforts of American Labor were through political parties which proved inadequate for either their immediate purposes or for expressing the wider ideals of the labor movement. After each political experience Labor turned again to the union method with more definite concen-

tration of endeavor in the economic field. Political endeavor has been always transitory.

The Civil War brought tremendous expansion in American industries in addition to developments in the railroad industry. Industrial prosperity brought its usual opportunities for union expansion. There was a marked increase in the number of unions and in the federation of local unions into national craft and trade organizations. There came also an increase in local federations of trade unions for common purposes. With union strength came wage increases and shortening of the hours of labor. The eight-hour day became an immediate goal. In 1866 there was organized the National Labor Union whose basic unit was the federated local labor body. This organization advocated coöperation and finally political action but did not survive its first political campaign.

When the financial crisis brought to end the war-time inflation, the unions shared the misfortunes of industry. They lost heavily both in membership and in local unions. They also had to meet the increasing volume of immigration that meant competition for jobs. As certain exploiting employers saw in competing immigrant workers a method for maintaining low wages and poorer conditions of work, the labor movement was early committed to immigration restriction.

From the disintegration of the National Labor Union in 1872 there was a period of industrial depression. Unemployment, low wages, desperate hardships for workers together with ruthlessness on the part of employers resulted in a wave of violence among workers to which more recent immigrants schooled in the revolutions of Europe contributed immeasurably. There were efforts to revive a national labor organization but first to succeed was that led by a group of trade unionists who modeled their plans after the British Trade Union Congress. This organization formed November 15, 1881, was called the Federation of Trades and Labor Unions of the United States and Canada. The program of this organization was at first chiefly legislative and steadily the paramount importance of economic problems and the promotion of trade unionism became increasingly apparent. Within the

labor movement itself there developed a conflict between the craft or trade form of organization and the amalgamated type represented by the Knights of Labor which joined together workers as wage-earners regardless of crafts or callings. The trade union type of organization sought to promote the economic welfare of workers through their trade organization which understood trade problems and sought to build into each trade higher standards for the workers which in turn would develop greater opportunities and responsibilities for them in their industrial relationships. The trade union sought constructive development within industry—an evolutionary procedure—while the Knights of Labor advocated changes in industrial forms and relationships. Trade unions were open organizations as contrasted with the secret nature of the Knights of Labor, which guarded its activity with ritual and unpublished proceedings.

As the Federation formed in 1881 did not adequately meet developing changes, leaders of trade unions in 1886 called a conference in which the old Federation was merged with a new distinctive trade union. The Federation developed its policies and methods under the leadership of a strong trade unionist, Samuel Gompers, who was associated with the development of the Cigarmakers International Union. The cigarmakers at that time had a strong organization with definite standards and disciplines necessary to organized undertakings. Mr. Gompers brought to the American Federation of Labor an experience and definite ideals which were the results of helping to develop trade unions for the cigarmakers and through his leadership in this national labor organization the American Federation of Labor helped to promote the principles and methods of trade unionism—constructive labor organization and activities—among workers in all callings and industries.

The American Federation of Labor initiated the first general effort to establish the eight-hour day by economic methods and centered its efforts on encouragement of further organization, the uniting of local trade unions into national organizations, and the consolidation of existing unions so there might

be no duplication of organization with resultant weakening of authority both within the wage-earners' group and within industry.

The period of the nineties was a time of strengthening and extending the trade union movement which bore fruit in the steady increases in membership that came with the twentieth century. Within industry also marked changes were taking place—the beginning of large scale industry or the trust. The concentration of capital in the corporate form of organization brought a new harshness and militancy into the attitude of employers toward their employees. Some of these trusts inaugurated policies of offering special inducements to foreign workers to emigrate to their plants. As these immigrants came from various South European countries they were separated by barriers of languages and customs that retarded organization into unions. So while organization was extending among workers in the crafts and smaller industries, there developed industrial areas under impersonal management with aggressive anti-union policies. It was in such industries that there came first a separation of management from owners. Management responsible for the direction of large work forces began developing management techniques and became recognized as a distinct function in industry.

Corresponding to the wider basis of industrial organization, unions in the twentieth century continued to consolidate their craft ranks so that there should be one union for a craft and then to meet common problems of all working within an industry, developed the Building Trades Department, the Metal Trades Department, and the Railway Employees Department. Other crafts met this problem by forming industrial types of unions such as the miners, the brewery workers, the textile workers unions.

The American Federation of Labor had been making sustained, healthy progress when the World War brought its dynamic changes. Even before the United States formally entered, our American unions were adjusting themselves to war production. New industrial demands brought conservative management and war prosperity. Industries were eager

to benefit through these conditions and less reluctantly agreed to workers participating in the advantages. The war itself was a reversal of many peace relationships and purposes. Under the convincing persuasion of common fear and love of a common country, the spirit of union for national service was readily carried over into war-time industries which to a degree never before recognized were accepted as an integral phase of the military activities. That there might be a nation united and operating on a basis of equal justice that assured morale, the government took the lead in establishing coöperation as a fundamental principle in industrial relations for war work. This principle established for war work was carried over into many private industries. Trade union organization became necessary for effective functioning of workers in accord with the war program, and trade union membership increased rapidly.

These war conditions were such that the purchasing power of wage-earners increased with industrial prosperity and thus developed a stabilizing element helpful then and in the transitional post-war period. Just at the close of the war the American Federation of Labor achieved a purpose toward which it had been working for a number of years—the formation of the Pan-American Federation of Labor. With the development of various countries of the western world and the expansion of their industries, the points of contact and the bases of mutual interests between the peoples of these countries widened. There had been a definite strengthening of ties between wage-earners, particularly the wage-earners of the United States and Mexico where industries and industrial interests freely extended across the political boundary line. Believing that there were definite regional ties which might unite the workers of the American continents, the American Federation of Labor invited the labor movements of the various countries to unite in a Pan-American labor movement for the purpose of promoting good will and understanding between the peoples of these countries. The Pan-American Federation of Labor has steadily grown in strength and effectiveness. It is an organization of people without selfish or mercenary

purposes, through which representatives of masses of the populations of Pan-American countries can develop confidence in each other and promote that good will invaluable not only for promoting and conserving the interests of wage-earners but for substantial and constructive relations between nations.

The Pan-American Federation of Labor has been a constructive agency for voicing and formulating public opinion that has proved a check upon military and financial exploitation of weaker countries and thus indirectly making for an atmosphere of confidence and cordiality which facilitates extension of industrial relationship within the western hemisphere.

Of tremendous importance to American industries have been the character and the policies of the American trade union movement. Human labor is indispensable for production and the labor movement is the agency that enables labor to keep pace with the changes and progress of industry. If Labor did not keep pace with changes in production and in consumption, it would impede or retard progress. From the first the American trade union movement has accepted as its function the protection and promotion of the human force in industry. It made basic in its program higher wages and shorter hours for producing workers—two ideals that are now accepted industrial and social principles. Insistence upon better conditions for workers has continually brought technical progress and higher standards of life for the nation together with higher ideals for its citizenry.

The American Federation of Labor has steadfastly opposed policies and programs of action that sought advantages for wage-earners through revolutionary proposals. It has looked to evolutionary progress and has influenced existing agencies toward higher ideals and more constructive development, instead of proposing to disorganize the existing order as a preliminary to reorganization for the special advantage of the wage-earning group. Our American trade union movement holds that the interests of all elements in production are interdependent and that permanent progress must be mutual in scope. It therefore made the foundation of its program voluntary organization of each group independently with definitely

agreed upon machinery and procedure for joint consideration of common problems and agreement upon decisions. This procedure which trade unions call collective bargaining is in the first case for the mutual determination of terms and conditions upon which workers are employed in industry. Collective bargaining usually provides methods for adjusting problems that may arise in the application of the work agreement. Well developed adjustment agencies minimize or avert industrial disputes.

The spirit of collective bargaining finds further manifestation in the union's recognition of increased productivity as necessary for permanent increases in wages and standards of living. The American labor movement does not oppose technical change or greater use of machinery. It has, however, insisted that unless the introduction of these changes is accompanied by consideration of the interests of workers concerned, the result will bring industrial and social problems, retarding human progress. Where the employed do not share in the results of increased productivity and technical progress, decreased purchasing power and unemployment bring their train of ills that contribute to the downward swing of the business cycle. Realizing these things in a practical way, trade unions have increasingly sought to contribute their experience and their understanding to the more effective management of industry. Such an advanced type of coöperation is possible only where confidence and agencies to maintain understanding exist. Such coöperation results in elimination of waste in industry. There are certain types of waste that are best known by those who handle the tools and materials and give material existence to the blue prints of industry. To coöperate for more efficient production is a creative enterprise which offers opportunity for growth to those who participate. But should this high type of work bring only to management those economic gains that make possible wider opportunities in living, any fine desire for creative coöperation is crushed by the manifest injustice. Coöperation is a thing that flows freely under right psychological conditions. Coöperation of wage-earners with management for a creative purpose in production follows the same

principles that underlie a human creative endeavor. The creative is of the spirit—the distinguishing quality of man. Creative production necessitates opportunity for expression and is hampered by restrictive conditions. Satisfaction in work comes from originating and carrying plans out. The individual workers in a large industry can have practically nothing to say about the making of decisions affecting work processes, but the workers associated together in a union have a real authority and freedom that make them an articulate element in production.

The potentiality of such constructive coöperation has been demonstrated by express agreements for union-management coöperation and by those arrangements and methods that grow out of collective bargaining without formal expression of purpose by union to share in the problems of production. Perhaps the most general expression of Labor's concern for good production is found in provisions for the maintenance of craftsmanship standards through apprenticeship training. Unions provide opportunities for apprenticeship training under union control and in coöperation with public schools. Some unions help their journeymen members to make further improvements in workmanship as, for example, the correspondence courses of the International Typographical Union and the technical school and engineering service of the Printing Pressmen's Union. The latter union retains three production engineers who watch craftsmanship on the papers with which its unions have contracts and who give technical advice where work falls below union standards. If suggestions by mail do not bring the desired results, one of the engineers makes an investigation of the shop and its machines, and then works out with the printing pressmen adjustments necessary to get better production results. Unions in crafts where quality is an important element in production, such as the full-fashioned hosiery and other textile crafts, have in many instances assumed important responsibility for the maintenance of quality standards. This responsibility has involved definite participation in management decisions. Paper mill employees under union contracts are definitely assuming responsibility for bet-

ter production and higher work standards. An upholsterers' union asked the employer to abolish the position of foreman and the union performed his functions. Many unions of crafts such as the photo-engravers, and the machinists, conduct employment agencies which perform a constructive service to their members and industries. Building trades unions and contractors of New York City have united in a plan to give special distinctions to workers who have contributed notable craftsmanship to the building of specific construction undertakings.

The spirit of collective bargaining has in the embryo the concept of work-partnership, that develops under favorable conditions. Such developments have come most notably on transportation undertakings—from railroads and a traction company. Over 75,000 men are concerned in union-management coöperation undertakings on the following railroads: the Baltimore and Ohio, the Chicago and Northwestern, the Chicago, Milwaukee and St. Paul and the Canadian National. The agency for carrying out the purpose is the joint shop committee composed of representatives appointed by the union and the management. These committees meet regularly, consider problems growing out of the work of the shop, and try to find ways for meeting the problems and improving work procedure. More than 18,000 suggestions have been made through the joint committees of the Baltimore and Ohio alone and have been put into shop practice. Many of these suggestions were concerned with production or engineering problems and some resulted in the development of tools and devices that amounted to inventions.

The development of union-management coöperation on the Pittsburgh Traction Lines in but two years have already resulted in suggestions for improvements in service that are of highest value to the industry.

That industrial production is an associated undertaking dependent upon the services of all concerned is the principle underlying union-management coöperation which some managements have sought to utilize without recognizing that coöperation must be mutual. In certain non-union areas, man-

agement realized the need of an agency which would enable it to deal collectively with the employees and which would also help in maintaining morale. Morale, as every management knows, represents the difference between unsatisfactory production and good results. Because of a tradition of non-union policies, management thought to follow an easier course and develop a substitute for unions. So developed company unions which are an extension of the will and purpose of management (not the workers) and are to bring the workers into line with management's plans. The difference between the company union and the trade union may be summed up in one word—volition. Because the company union is not voluntary it does not result in the mutuality necessary to coöperation which is joint creative thought and work. Company unions unless associated with insurance against the misfortunes of life, cannot satisfy the desire of human beings for voluntary opportunities for creative work, nor give to industry the highest quality of service that makes for sustained development.

The American trade union movement stands four-square for constructive policies. It believes in developing present institutions toward higher levels of achievement by putting to work the creative abilities of those working in the industry. It believes that Labor should share in industrial and social progress through shorter hours of work and higher compensation. It believes that not only should wages increase in amount and in purchasing power but in proportion to increases in productivity of industry. It believes that increased production is necessary to higher standards of work and life. It believes decisions upon these matters should be arrived at jointly upon a basis of facts and is endeavoring to develop the necessary fact-finding agencies. It believes that the problems of industrial relations and of coöperation in production must be worked out within industry by the organized elements concerned. It is opposed to restrictive outside regulation and believes in educational methods as the dependable procedure for real progress.

This summary of American Labor's proposals indicates definitely the reasons for our opposition to the use of the in-

junction in industrial disputes as the injunction represents arbitrary authority used to sustain the employer in his contentions against his employees. Industrial disputes can and should be adjusted by voluntary economic methods.

The policies and declarations of the American Federation of Labor constitute a challenge which American industry must consider. Our movement offers a constructive agency whose coöperation makes possible the building of industrial organization adequate and resourceful to the extent of man's creative capacity for the opportunity for voluntary endeavor is freely available. Upon industry rests the responsibility for choice of organization for relations between those associated together in the work of production. Coöperation comes only when both management and workers reach mutual agreement. Workers alone cannot establish coöperation, nor is it possible unless both groups have confidence in each other. Management has a strategic position that involves responsibility for initiative in action. Management may make decisions and give orders but it cannot accomplish its purposes unless those who handle the tools and materials of production share management's purposes and wishes. The only way to reach that harmony of thought and will which constitutes coöperation in industry is through discussion and mutual decisions reached through spokesmen for each group meeting on an equal footing.

Looked at from another point of view, it is evident that management or the making of plans for production can never be absolutely delegated to one group, but that all those who execute work orders modify to more or less important degrees in accord with their understanding or will to coöperate. The only way to have unified purpose and action is through collective agreement upon ways and means.

Industry may choose coöperation with a constructive trade union or the repression and the separatist influence of projecting management's decisions as final in all issues however vitally workers may be concerned. The second decision leads inevitably to conflict and chaos. There is no middle ground.

XXII

THE ELECTRIC INDUSTRY

By Owen D. Young
Chairman of Board, General Electric Co.

ONE hundred years ago the Industrial Revolution was well launched in its daring attempt to transform the world. Yet the changes it had wrought in the days of Pitt, Washington and Napoleon were as nothing compared to those of the next fifty years. And these changes, in turn, are apparently dwarfed by those of the last half century.

Transforming the world, as reformers will testify, is no easy task. Yet the Industrial Revolution has done it. Its offspring are still doing it, with a speed which is sometimes as bewildering as it is amazing. Where civilization was once static, it has become dynamic; so much so that our chief problem is no longer to adjust ourselves to a well-defined system but to change. This has been particularly true in these United States, and it is precisely here that the Industrial Revolution and its vigorous children have had the largest and freest scope.

The Electric Industry is among the youngest of this prodigious family. It was born scarcely half a century ago. Precocious even in infancy, its imagination was so fired by the aspirations and traditions it inherited, that already the achievements of the child surpass the dreams of the father. It has made allies of many of its older brothers. And still it is a mere youth with its greatest opportunities still before it.

But if the sire of the Electric Industry was a dreamer of dreams and a doer of deeds, no good biographer can afford to neglect the mother. And if the Industry was sired by the Industrial Revolution, it owes its birth, as it still owes its growth, to Electrical Science. The names of both parents are appropriately perpetuated in the child.

I

In 1931 occurs an important centennial. For it was in 1831 that Michael Faraday, the renowned English scientist, performed the series of brilliant experiments from which dates the whole modern development of electrical knowledge.

Before Faraday, there was nothing upon which to build even the beginnings of an industry. Volta, to be sure, had made invaluable contributions to the science, and electrical energy was still largely derived from crude batteries, the logical outgrowths of the famous "voltaic pile." But such currents as these batteries yielded were inevitably weak. Apparatus larger than a call bell or a telegraph instrument they could not adequately supply. Oersted in Copenhagen and Ampère in Paris were perfectly well aware of this and did much to solve the problem.

But Faraday profited by their work and went beyond them. Electro-magnetism is associated preëminently with his name because the closely related principles of electro-magnetic rotation and electro-magnetic induction were established by his experiments. And as a result of Faraday's discoveries came the first rotating electric machines.

Here was a new source of energy with possibilities far more wonderful than the battery's. The importance of the dynamo can scarcely be overestimated, and the dynamo developed as logically from Faraday's work as the battery did from Volta's. It embodied the idea of producing electric current on a practical scale by mechanical rotation. It made it apparent that there must be some method of utilizing this principle to generate that current in volume and to do it economically.

The next four decades saw these promises redeemed. Dynamo-electric machines had followed the discoveries of Dr. Werner von Siemens in Berlin and Dr. William von Siemens and Sir Charles Wheatstone in London. It was left, however, to Pacinotti in Italy and Gramme in France to introduce the ring armature for dynamos, which substituted a continuous for a pulsating current. While the Prussians were overturning the

second Empire in the memorable year of 1870, Gramme designed and exhibited his dynamo, shortly after Pacinotti had shown his model. Within the following decade the first commercial dynamos appeared, and practical applications of the electrical current, confined at first chiefly to illumination, swiftly followed. At last a durable foundation had been laid.

I have already said that the importance of the dynamo can scarcely be overestimated. It called into being not only the electric power and light companies but also the manufacturing companies which supply their apparatus. The Electric Industry as we know it to-day could not exist without it.

The battery, however, has its uses, and indeed it anticipated the dynamo in putting electricity at the service of the people. Neither the telegraph nor the telephone requires a large volume of electric current. Pioneers in the application of electrical knowledge to human affairs, these American inventions descend directly from the pioneer period of the science, and are monuments not only to Morse and Bell, but also to Volta.

The year 1876, when Bell had his first success with the telephone, was important in more ways than one. It was then that Charles F. Brush, in Cleveland, not only produced a commercial dynamo but supplemented it by an equally useful arc lamp. When in the same year he began to offer the two upon the market as component parts of an efficient electric lighting system, one might have discerned the first faint glimmerings of the Electric Industry.

Similar ventures soon followed. There was, for example, the arc lighting system of Elihu Thomson, first introduced as a commercial venture in Philadelphia in 1881.

Both of these systems soon enjoyed a considerable popularity. And both soon encouraged the formation of unpretentious manufacturing enterprises. Within a few years the sales to customers began to produce an appreciable revenue.

II

The next years saw significant developments. Already in 1879 and 1880, Thomas Alva Edison had introduced an incan-

descent electric lamp which stood every test of practical usage. This lamp was to be the nucleus of such an expansion in the industrial field as had never before been dreamed of.

It cannot be doubted that Edison conceived a comprehensive plan for establishing electric lighting in America. It is equally true that in some respects the promoters of the arc lighting systems—Brush and Thomson, in particular—had previously proceeded along similar lines. But Edison's incandescent lamp was peculiarly adapted, by its very nature, to carry the basic idea which was really common to all these pioneers to its natural conclusion in a broader field.

Edison, from the moment that he first turned his energetic mind to the problem of the electric light, contemplated the possibility of a system of the utmost practical value. He thought, from the outset, of supplanting the gas-light then widely used in the urban homes of America. He conceived his famous three-wire system, radiating from a central plant where electric energy could be generated by dynamos of the utmost efficiency, and he himself developed such a dynamo as an essential part of his comprehensive system.

From such central plants—or central stations—electrical energy was to be distributed to the customers of the service. The commodity to be offered on the market was electrical illumination through an incandescent electric lamp. The lamp was convenient in size and easy to control. It was apparent, therefore, that the people at large were now to enjoy the benefits of electrical research to an extent that had hardly been possible before, even with the telegraph and the telephone.

Through his characteristic faculties of intense energy and remarkable persistence, Edison soon realized his dream. His practical system of distributing the electrical energy between dynamos, lamps and motors was, perhaps, the keystone of his work, for it permitted a high degree of flexibility and the utmost independence of control in the use of electrical energy.

Having done this much, however, he did not rest. He saw the enterprise through to its final state—to the point of actual usage, of practical commercial success. He personally planned and superintended the establishment in New York City of a

central generating plant. By means of underground conductors, electricity was distributed from this central station over a section of Manhattan approximately a mile square.

Like his contemporaries, Edison quickly discovered that no existing factories anywhere knew how to build the equipment for his first central station. Consequently he organized his own manufacturing companies. Here, too, he exercised the closest personal supervision; like Thomson, who was often to be found assisting the workmen in the shop, and Brush, who more than once put on overalls to help the installation of a lighting plant. These men were true pioneers, for there was nothing that they did not do. The age of specialization came later.

When, at 3 P.M. of September 4, 1882, Mr. Edison put into regular operation in New York City the Pearl Street generating station and distribution system, there were eighty-five buildings connected for electric lighting service, and on that epoch-making afternoon 400 lamps were lighted. By the end of the year the company had 231 customers, with 3,477 lamps connected. For several months after commencing service, no bills were presented and no revenue received, so that prospective customers might have an opportunity of testing this new mode of lighting.

It was a momentous milestone in American economic history, this first generating station of Edison's in lower Manhattan, and as such it is worthy of more than passing notice. The plant was established at 257 Pearl Street, where Edison and his men worked day and night, installing the equipment. The electric current was produced by six Edison dynamos, of monster size for that day of modest machines. They were popularly styled "Jumbos," and they were prophetic of modern practice in being connected directly to steam engines, without the use of driving belts. Their combined capacity was 600 kilowatts, and the electric current which they produced was transmitted no farther than a mile, at a pressure of 110 volts. At the very beginning the current was actually sold by the lamp hour, the kilowatt-hour unit not having been introduced as yet. The original cost of lighting from the pioneer plant in 1882

was 1.2 cents per hour for a lamp of 16 candlepower. This is equivalent to 13 candle-hours for a penny. To-day an American penny will buy 125 candle-hours at average retail prices. In other words, making no allowance for the decline in the purchasing power of our money, the efficiency of the generating, distributing, and incandescent apparatus has increased ten-fold.

The original investment in property and equipment represented about $600,000, and at the end of the first year the station sustained a net loss of $4,400. By that time, however, there were some five hundred customers to whom current was being supplied, and this number gradually increased with every succeeding month. The second year of operation produced a profit of $30,000. It is said that never thereafter did this station fail to earn a return on the capital invested.

This was America's first central station for commercially supplying incandescent electric light through an underground system. In most respects, it was the prototype of the modern central station. It set up precedents of engineering practice which have never been forsaken. It was the actual nucleus of one of the present great utility companies in New York which supply electrical energy for the multitudinous needs of a great modern metropolis.

Edison was not alone in his efforts to supply electric illuminating current from central stations. As early as 1879 an unpretentious central plant was established in San Francisco, which supplied current for a system of arc lamps. The lighting system and equipment were those of Brush, and the customers included the municipality of San Francisco—for which certain streets were illuminated by arc lamps suspended from tall poles, 150 feet high—and a few theaters, hotels and large mercantile establishments.

This venture was capitalized at $500,000. The rates which the customers paid were originally ten dollars a week per lamp, with the understanding that the current would be switched off at midnight. After a time the price was reduced to a maximum of three dollars per week up to half-past nine, with higher rates

for illumination beyond that hour. It was carefully stipulated that no current would be supplied on Sundays or holidays.

These two plants, in New York and San Francisco, served as models for many others. By the time the Electric Industry was ten years old, it had begun to show many modern characteristics. Power and lighting companies—the so-called public utilities—had appeared. Manufacturing companies were producing and selling essential equipment. Increasing interest was being manifested in the new service. The very products which were being marketed were being improved by experiments in the laboratory.

Even to-day, though many products are relatively standardized, this remains astonishingly true. Individual enterprise, a zest for new inventions, impatience with imperfections—such is the atmosphere which the industry breathes. I know of no healthier atmosphere.

III

In the middle eighties, the electric industry was confined almost wholly to illumination. This service, however, quickly extended to electric motors, soon became unceasing. Barring accidents, no limits of time were recognized, and limitations of space were diligently assailed. The business of the manufacturing companies was simply to provide central stations and individual customers with every type of equipment they required.

Shortly before 1890, however, a new group of inventors and pioneers appeared. It was then that such men as Van Depoele, Bentley, Knight, Daft, and Sprague succeeded in producing electrically driven street cars. Not content with illuminating the city, providing industrial power and speeding communication, electricity was also to revolutionize transportation. Horse cars were picturesque but cumbersome and inhuman; a nuisance in the city, impractical for interurban or rural lines. Steam-driven locomotives, invaluable as they were, and are, created a veritable wilderness of smoke and soot about the great metropolitan terminals. The amazing transformation of

Park Avenue, in New York City, is a splendid illustration of the blessings which were to attend electric locomotion. The elevated railways, subways and suburban transit lines which make possible greater Chicago or greater New York, all trace from this first small beginning.

This, of course, is anticipating the story. Nevertheless, by 1890, some three thousand electric street cars were being propelled over two thousand miles of track. As a result, new generating plants arose to furnish power for transportation, and the manufacturers built dynamos for the plants and motors for the cars.

To a much more limited extent, electric power and electric heat for industrial processes had also been introduced. But the volume of electrical energy thus used, up to 1890, was relatively light.

When the last decade of the century opened, the Electric Industry was still a mere stripling. Fifty millions represented the entire capital of the manufacturing companies. About twelve hundred public utilities were operating, most of them modest to a degree, using rather primitive equipment, and often serving a mere handful of customers.

It is true that the future, broadly viewed, was bright with possibilities. The people were gradually appreciating what electric service might do for them. Skepticism—and there had been a great deal of it—was passing. The army of prejudiced folk was large, particularly in the smaller communities; while even in the more sophisticated cities, the sight of a queer light inside a glass bulb, obeying the pressure of a button, was incomprehensible. And to see a street car moving along without any visible means of propulsion suggested the supernatural.

But this young and promising industry, transforming into a service a mysterious force of nature, faced serious problems. The competition which naturally arose as the companies grew was often healthy neither for the industry nor for the public.

For example, various patents, essentially complementary each to the other, had become the exclusive property of competing companies. This meant that there were always missing links in the chain of progress.

Again, new discoveries were announced by Stanley and Bradley and later by Tesla, which led to significant developments in the use of alternating, as distinguished from direct, current. Operated at higher pressures, the alternating current, together with the new transformer, permitted the economical transmission of electrical energy over greater distances than ever before.

Conspicuous among those who saw and developed the virtues peculiar to the alternating current was George Westinghouse. Born of a family of engineers, famous himself as the inventor of the air-brake, his contributions to the Electric Industry were as various as they are important. It was largely through his efforts that the effectiveness of the alternating current was so dramatically demonstrated at the Chicago Exhibition in 1893 that it came to be widely used for power and lighting. It was under his direction that such inventions as Tesla's induction motor were developed, giving new and convincing impetus to the long distance transmission of power.

But like Edison, George Westinghouse did not confine his contributions to a single field. Under his leadership there appeared not only in America, but also in Europe, the many factories and enterprises which still perpetuate his name. His work in organizing and operating these manufacturing plants was of the sort which has established the industrial preëminence of the United States. Wherever one turns in this electrical world one finds his monument.

Now each of the two kinds of electric current possesses peculiar inherent advantages. Yet each had its partisan supporters, which gave rise to two schools of engineering practice.

Gradually it became obvious that this situation could be improved. A trend thereupon set in toward conciliation and unification. Consolidations took place which at once increased the efficiency of the industry and stimulated the progress of the science. This meant vastly improved service for the future. If the companies were immediate beneficiaries, the public was residuary legatee.

As isolated patents were fitted together, many a vexing puzzle was solved and technical progress was correspondingly

rapid. As the resources of several companies were combined, it was possible to undertake many new developments for which coöperation was essential. And each new development promoted others. Larger central stations demanded new and larger equipment; larger enterprises placed fresh responsibilities upon the management; vistas of future growth served to stimulate invention. Most important of all, perhaps, was the product of all these factors; namely, the growth of a new confidence, a new pride in the industry. For if an industry is to discipline itself and set up for itself high standards of social practice—if in short it is to become a profession—such a confidence and such a pride are indispensable.

Meanwhile a new factor, the utilization of waterpower, "white coal," became active. Hydro-electric operations at Niagara Falls began in 1894 with the installation of water-wheel generators of 5,000 kilowatts capacity—the maximum thus far attained. Here was a new source of energy, of which even to-day only a fraction has been utilized. When water power ceases to be the plaything of politics, when understanding replaces suspicion and recrimination, vast quantities of power will be released for the public service.

It was in consequence of the rapid growth which took place in the last ten years of the nineteenth century that large-scale financing became a necessity. Indeed, the capital required to facilitate this growth, particularly in the case of the electric public utilities, soon gave to the enterprise many of the aspects of a major industry. By 1900 the investment in these nation-wide central station companies was not far from a billion dollars.

One of the results of this period of conciliation, consolidation and growth was that new attention was paid to questions of management. The reason for this is obvious. Every industrial enterprise has responsibilities—to the men who work for it, to the people who entrust their money to it, to the public which it serves. The larger the enterprise, the greater the responsibility. The contribution of the men who have managed the electric industry is simply incalculable.

Many great figures might be mentioned, but the acknowl-

edged leader in the field of management was Charles A. Coffin. What Mr. Edison is to electrical invention, Mr. Coffin was to the electrical business. His greatest gift was to inspire human beings and to bring out the best there was in every man with whom he came in contact. He had early the vision of what electricity might do and he had unequaled courage in the formulation and execution of a business program. His faith in the industry was equaled only by his indomitable energy.

Not only did he stimulate to fresh achievement the technical and engineering departments of the industry, but more than any other man, perhaps, he made the people of this country understand the benefits of electricity. As this understanding grew, customers multiplied rapidly and the industry was enabled to make corresponding strides in extending its service.

Of great skill in dealing with manufacturing problems, of unparalleled courage in creating concerns to finance and market their product, Mr. Coffin made a contribution by his inspiring career which did as much to stimulate the development of the industry as any given invention.

And he was only a conspicuous figure among others who devoted their talents and their lives to the industry. Such devotion can not fail to bring great results.

IV

Whatever may be said of the twentieth century, it has unquestionably provided its share of the dramatic. And the Electric Industry has played an increasingly prominent rôle on the stage. The career of a man like Steinmetz, for example, is a drama in itself.

The twentieth century introduced the steam turbine. Far less bulky than the old reciprocating engine, it enabled the power stations to double their output without increasing their size. To-day the central station industry is literally built around the turbine generator. In 1903, it took courage to install in Chicago a 5,000 kilowatt unit; as I write these words, a generator of 208,000 kilowatts is under construction. The steam turbine of 1905 burned one and two-thirds pounds of

coal to produce one kilowatt hour of electricity; two decades later it burned less than half that amount. Such economies as these the Electric Industry has passed on not only to the household consumer, but also to other industries. It has profoundly affected the whole social and industrial fabric.

We have already seen how natural and inevitable was the tendency of the small isolated plants to combine. The present tendency of the larger plants to coöperate through interconnection is equally natural, and equally promising. It is the fashion in certain circles to decry such coöperation and alarm the public by the cry of "power trust." Where the alarm is genuine, it is unquestionably based upon misunderstanding, and if this is true, a simple explanation may not be out of place.

I have said elsewhere that the story of electric power is not unlike the story of the farm. In the early days, the power field had to be cleared of obstructions, just as the farmer's field had to be cleared of trees and rocks. It required the same spirit of the pioneer. Optimism and courage were the keynotes of both, and hardships and discouragements came to both. Fortunes were wiped away in the early days of electrical development, just as lives were lost in the effort of the agricultural pioneer to subdue the land. Production began in a small way and in the most fertile fields. The electric power man sought the rich and concentrated market, just as the farmer sought first the well-watered bottom land. The electric power man sought street lighting in the cities, because that was the simplest and easiest crop to grow. He later extended it to house lighting and then to traction in place of horses. And finally, he applied this new energy to industrial operation, and thereafter the emphasis was placed on power rather than on light.

To-day, the electric power man has learned what the farmer is learning, and that is that the success of his business depends upon diversity. He has found that diversity is important both in the generation and the use of his power. If he can tie into the same system water power generating plants located in separate watersheds and on rivers having different conditions of flow, then he can take advantage of the diversity of rainfall and thereby insure both a cheaper and more continuous power

supply. If the power man can serve many different power users in the community, he finds that he can serve them all with much less investment than if each tried to serve himself.

If one were to run a single elevator, he would require a generator and motor of a capacity able to lift the elevator with its load, but that generator will only work half the time; that is, when the elevator is going up. It will be idle when the elevator is coming down. If one were to run a bank of twelve elevators, it is probable that he would only require a generator sufficient for six, because it is fair to assume that only half of them would be going up at once—the other six would be coming down. Therefore, the motors and generator might be working all the time, and the cost of investment service would be cut in two.

That is the reason why the power companies are seeking diversity of application, and that is why they are seeking diversity in generation. Great plants, economically located, are tied together in one great transmission system. Similarly, cities having different kinds of industry and different times of utilization are all tied together in these great power systems in order to get the maximum service from the minimum investment. City is tied with city now instead of each being served by its local plant, and electric lines reach out through the country for the purpose of making this economical network of power supply.

The twentieth century has seen a multitude of other improvements. Not only the generating but also the current-consuming machines have been revolutionized. Electric motors, for example, have been so developed that to-day there appears to be a type for almost every conceivable purpose. The smallest can easily be held in the palm of the hand; the largest would reach to an ordinary ceiling. Electric furnaces and heaters made their début somewhat later than the motors, but quickly found fields of usefulness. Still more recently, electric refrigerators have been marketed.

But the great romance of progress among the devices which consume electric current remains with the incandescent lamp, Edison's brilliant creation. Research, both in America and

abroad, has vastly improved the incandescent lamp—without, however, altering in the slightest the fundamental elements originally combined by Edison to produce it. The growth of its usefulness to the public is best suggested by the fashion in which the electric light is taken for granted to-day. To the great majority of us, it is no longer a seven days' wonder—it is a virtual necessity.

Comparison of costs is prosaic enough to many, yet few will object to prose which records a constant reduction in prices. That this record is true of the Electric Industry is due in no small part to the devotion and ingenuity of outstanding technical experts, many of whom are still living. The direct outcome of their remarkable work becomes graphically apparent in a statement issued by electric lighting engineers in 1922. If the intensity of lighting purchased by the public in that year had been obtained by using the incandescent lamp of 1892, the statement declares, then the cost of electric lighting to the public would have been increased one and a half billion dollars. Moreover, twenty-five million additional tons of coal would have been required to generate the electricity which the volume of electric lighting in 1922 would have absorbed.

Technical progress, manufacturing economies and commercial efficiency have been a boon not only to the industry, but also to the consumer. Even more important, in many respects, is the fact that the Electric Industry is a coöperative enterprise. Representing as it does to-day an investment of over ten billions of dollars, the industry numbers among its stockholders hundreds of thousands of customers and employees. It recognizes as never before its obligations to all those with whom it is concerned—which is practically the equivalent of that inexact term, the public. Since 1890 the cost of living has more than doubled. The cost of electricity, however, has fallen, which puts this commodity in a class by itself. Moreover, it has dropped while other costs have risen—the two behaving rather like the buckets in a well.

V

The growth of the electrical industry has been so rapid that at first glance it appears slightly fabulous. It is as if Aladdin had rubbed his copper lamp and sent a fresh current of life and power into the factories and the farms, a new flood of light and warmth into our homes. This has indeed occurred, but vastly more than this. For at a small price each worker, each housewife, each citizen, and to some extent each farmer, can now purchase an Aladdin's lamp of his own, and thereby command genii whose ministrations are as various as they are constant.

The mysterious power of electricity has entered sixteen million American dwellings, serving therein nearly three-fifths of the American people. It will do far more than light the lamps. It will wash and iron the clothes and clean the carpets. It will cook the dinner and fill the ice chest. And now it is ready to bring entertainment and instruction over the radio. But the story of that precocious infant of infinite possibilities is admirably told elsewhere in this volume.

The cities are usually the first to profit by such developments, and the reasons are obvious. The radio is a significant exception. And now at last in other ways the rural districts are beginning to challenge urban monopolies. Already over three hundred thousand farms are served by power and light companies. This is a mere beginning, but wherever electricity once gains a foothold it has invariably made rapid progress. And nothing can ultimately accelerate this development, so greatly to be desired, more than interconnection.

Power companies, as we have seen, have found it to their advantage to run great lines through the country districts in order to tie dozens and perhaps hundreds of cities and towns together. Why this is to the industry's advantage and to the public's advantage, I have already tried to demonstrate. It is to the farmer's advantage because it may mean that electricity can be made available to many remote areas, isolated hamlets and groups of farms. There are still grave technical difficulties to be overcome before this end can be achieved. Substations

are necessary to reduce the voltage before the high power of long-distance transmission lines can be successfully utilized. But the social obligation is clear, and I venture to predict that this problem, like other problems the industry has faced, will be solved.

Not only has electricity entered the home, the office and more and more farms; it has gone into the factories. Here its contribution has been incalculable. The Industrial Revolution, in its transforming zeal, often reduced order to chaos, and chaos is uncomfortable even when it is ultimately to prove fruitful. Electricity has done much to restore order, but a new order. Quite aside from its effect in bettering physical conditions in the factory, for example, there is its significant influence on the position of the worker.

Rousseau did not produce the French Revolution. No one factor suffices to produce any revolution. Nevertheless, the position of the American worker has been revolutionized, and it is not too much to say that electricity has been the greatest single cause of the change.

Each worker used to be a generator of power. In 1869 the power at his disposal in these United States was six-tenths of one horsepower, or less than eight "man-power." To-day there is available for each worker four and one-quarter horsepower, the mechanical equivalent of some fifty-five human servants. Three-fourths of this power is furnished by electricity. To an extent not even approached at any other time or in any other land the American worker is now a controller of power.

In his new position of comparative dignity, the shop worker can produce more and produce it more easily. Increased production means higher wages, higher wages spells increased consumption, and this in turn supports the new scale of production. Such a formula as this is perhaps not watertight; nevertheless, it embodies an important discovery which has enormously benefited the worker.

An exhaustive catalogue of electrical developments is out of the question here. I have not even mentioned the contributions to medicine, like the X-ray; I have scarcely mentioned the ele-

vators which make practicable the skyscrapers of to-day. I have not mentioned electricity's contributions to the automobile, to the airplane, to naval vessels; I have scarcely mentioned its contribution to education and recreation.

It is enough if the reader has realized that the electrical industry is woven into the very fiber of our individual and national existence, and into the delicate fabric of international relations. It is enough if he has realized that it has succeeded because it has served not only individual and industrial but also social and scientific needs—because, in short, it has made itself indispensable. In making the nations neighbors as never before, it has indeed transformed the world.

The public service corporations of to-day are supplied by a manufacturing industry of seventeen hundred establishments. In these plants 300,000 employees are producing annually a product valued at one and one-half billion dollars. Among other items, these plants manufacture and sell half a billion incandescent lamps each year in America alone, or nearly one-half of the world's output.

Electrical developments are at once the result of, and a constant challenge to, the spirit of individual initiative. Perhaps the industry's most characteristic feature is this: that, far from being content to meet needs as they arose, it has anticipated them. An industry with such a record and such an *esprit* is bound to succeed. If it also enjoys the exceptional leadership which the electrical industry has possessed, its phenomenal success is no longer a mystery without a key.

Not long ago a certain Parisian was making his first visit to New York, and of course his American host asked the inevitable question. "What do I think of it?" repeated the visitor, as he turned his gaze from a skyscraper to a block which was being razed to make room for more skyscrapers. "I think it will be an amazingly fine city—when it is finished."

Of course, the beauty of New York is that it is never finished.

The Electric Industry is like that. Half a century ago there was no Electric Industry and Trinity Spire was the undisputed

giant of Manhattan. But just as a new architecture has reared, on a startling scale, the towers of to-day, so the Electric Industry has been developed by its architects until it approaches epic proportions. Both these phenomena are recognized to be distinctly American contributions, in which Americans may take a just pride.

Yet both are far from completion. The end of electrical development is not even remotely visible. Electrical scientists recognize absolutely no boundary, no limitation, in the opportunity for service presented by the future. The amazing developments which have just been recorded, therefore, far from exhausting our creative ingenuity, ought rather to suggest the enormous possibilities which lie before us, and fill us with a fresh zeal for their realization. The solid achievements of former generations were due to the foresight and devotion of the young men of the past; the boundless future is in the hands of the young men of to-day.

XXIII

TELEGRAPHY AND TELEPHONY

By Frank B. Jewett

Vice-president, American Telephone and Telegraph Co.

TO-DAY, the United States, Canada and Cuba are in direct telephonic communication with Great Britain. Across three thousand miles of water, new world and old world business men confer with one another daily. Banker talks with banker, merchant with manufacturer, and tourist and traveler with friends at home. The Atlantic Ocean, long a barrier to all forms of electrical communication except the wavy line of the siphon recorder, is now bridged by the voice as though it were but a pool. Probably few indeed of the present-day transatlantic voyagers realize, while in mid-ocean, that traveling through the ether around them are other and invisible voyagers making the three thousand miles journey for but a few moments' time and at a speed which is only less than that of light itself.

The transatlantic telephone connection is neither wire nor radio—it is both. A connection from New York to London comprises about seven hundred miles of wire and some three thousand miles by radio. It is, of course, the radio which spans the ocean. However, if one talks from San Francisco to a party, say, in the north of Scotland, the total length of the wire path provided for the voice considerably exceeds the length of the radio path. Transatlantic telephony therefore involves the instantaneous coöperation of long distance telephony by wire and by radio.

The wonders of radio telephony are recognized by every one to-day. The wonders of wire telephony although less apparent are none the less notable. In speaking from New York to San

Francisco over a transcontinental line, the voice currents are amplified a million-millionfold and yet arrive with all the clearness and intelligibility with which they start, preserving even the identity of the speaker. In the storm-proof cable connecting Chicago and New York the time of transmission is sufficient (about one-tenth second) to cause a confusing echo, and the speaker's voice therefore operates an "echo suppressor," an automatic traffic signal, blocking the return of any echo. By means of a multiplex high frequency principle, many long distance lines now carry as many as five telephone messages simultaneously on each pair of wires. Electric filters, the invention of the telephone engineer, separate the messages from one another as readily as a gravel sifter sorts out stones of different sizes.

Nor are the wonders of telephony all in the mysterious electrical tricks it accomplishes. The magnitude of the telephone task is no less impressive. Last year the American Telephone System carried twenty billion communications,—an average of one message every day for every man, woman and child in the country.

The total distance covered by these twenty billion messages was over fifty billion miles. Assuming that equally satisfactory results could have been obtained had these messages been carried by special messengers, it is interesting to estimate the physical magnitude of the task involved. Assuming that each messenger works nine hours per day and averages ten miles per hour, it would require six million messengers and, at a conservative estimate, would cost ten billion dollars to handle the business which the telephone handled for less than one-tenth as much, and with three hundred thousand employees.

Fifty-two years ago there was one telephone in the world,—the instrument which Bell invented. To-day there is in the United States one telephone for every seven persons.

Fifty-two years ago there were two telephone employees,—Bell and his assistant. To-day there are three hundred thousand.

Fifty-two years ago the world's entire telephone plant could have been held in one man's hand. To-day, in this country

alone, there are, among other items, eighteen million instruments, over six thousand central offices, and fifty-six million miles of wire, the whole telephone plant representing a cost of over $3,000,000,000.

Without the telephone, the modern skyscraper would be more an encumbrance than an aid to business. To carry by messenger the telephone communications which enter and leave a tall office building during the rush hours would block corridors and elevators, and produce an unprecedented traffic jam in near-by streets. For every person who walks along a busy city street the telephone enables a dozen to project their thoughts and personalities along the circuits below the street. The telephone delivers a message and brings the answer in less time than it would take to transcribe it for a messenger.

The telephone is as indispensable to the farmer as to the business man. It not only aids the farmer in his work but, together with the automobile, has removed him from his isolation. It is estimated that on the average one out of every two American farmers possesses a telephone.

It is difficult to imagine the far-reaching changes which would be necessitated in our industrial and social worlds were the telephone to be removed. It is no exaggeration to say that it has assumed as fundamental and important a part in our economic structure as have the railroads and electric power. To-day our telephone system covers the United States as a far-flung and delicate web, making possible direct intercourse between persons in practically every city and hamlet throughout the entire length and breadth of the land. Recently a notable reduction in the time required for long distance connections has been effected, 90 per cent. of the calls between New York and Chicago now being completed within three minutes.

At the present time the United States can boast of one telephone for every seven persons and the relative number of telephones is steadily increasing. There are upwards of eighteen million telephone instruments distributed throughout the country and joined by approximately fifty-six million miles of wire.

The first telephone switchboard was installed in 1877 in

Boston by an enterprising young electrician, E. T. Holmes, and connected five banks. It served as a telephone system by day and a burglar alarm by night. In fifty-two years this single switchboard has developed into over six thousand offices, so that scarcely a settlement in the entire country but has its telephone service and connections with the outside world.

In New York City at the present time there are about fifteen hundred thousand telephones which connect with one another through one hundred and forty-four different central offices. The switchboards of these central offices constitute one of the most important of all telephone developments. They are of the multiple type, so called because of the fact that each subscriber's line that terminates at the switchboard is duplicated or "multiplied" on every section of the board and hence within the reach of many operators. The largest switchboards, namely, those designed to handle the lines of ten thousand subscribers, are attended by about one hundred and fifty girls to care for subscribers originating calls, and by about fifty girls to complete calls incoming from distant offices and destined for subscribers within the office area. All these girls have direct and immediate access to every one of the ten thousand subscribers' lines.

To accommodate the rapid growth of the telephone, switchboard design became one of the most vital problems telephone engineers had to face early in the art.

Another problem had to do with the placing of the telephone circuits under ground. Those whose memories go back beyond the year 1900 will recall the great masses of overhead wires, partly telephone and partly telegraph and power, which darkened the streets of our large cities. After many years of research into problems ranging all the way from the involved mathematical theory of telephone transmission to problems dealing with the thin paper insulation to be used where transmission wires are packed closely together, a solution was found. Underground and aerial cable is now in use in every city in the country to supply the bulk of the circuits running between subscribers and the central offices.

The best idea of the enormous saving in space which cable

effects is given by some figures relating to New York City. At the corner of Seventh Avenue and 36th Street there are more than one hundred thousand lines underground. This vast number of wires, if placed upon a single overhead line, would require poles four miles high. If the poles were only as high as the Woolworth tower, the streets would be roofed in by twenty-five such gigantic lines and a veritable canopy of copper.

Ever since the first underground cables were installed under a few city streets over twenty years ago, the technique of making telephone cables has advanced steadily and many of the cables in use to-day, although only two and five-eighths inches in diameter, contain twenty-four hundred wires. The great saving which results from the use of such local cables may be illustrated by the fact that a single twenty-four hundred-wire cable carries as many circuits as could be placed upon forty large pole lines. Together with the increase in the enormous number of telephone lines that can be placed in a single cable has gone a corresponding reduction in the size of copper wire required for each circuit.

Many subsequent telephone developments were presaged by Alexander Graham Bell, the inventor of the telephone. In a passage of a letter which he wrote to an early associate he prophesied as follows:

"It is conceivable that cables of telephone wires could be laid underground, or suspended overhead, communicating by branch wires with private dwellings, country houses, shops, manufactories, etc., uniting them through the main cable with a central office where the wire could be connected as desired, establishing direct communication between any two places in the city. Such a plan as this, though impracticable at the present moment, will, I firmly believe, be the outcome of the introduction of the telephone to the public. Not only so, but I believe in the future wires will unite the head offices of telephone companies in different cities, and a man in one part of the country may communicate by word of mouth with another in a distant place."

From the very first Bell and those associated with him in

the early development of the telephone foresaw and, with the wisest foresight, provided for the future success of long distance telephony. Among its problems are the most difficult and fascinating that the telephone engineer has ever had to face.

Space will not permit a detailed account of the many developments which have, in one way or another, contributed to the success of the network of long distance circuits which extends throughout the country. It must suffice here to mention one or two. These will serve also to illustrate the practical value that resides in the discoveries of the pure scientists. Those who pride themselves upon being practical are frequently guilty of failing to recognize the immensely practical contributions which science has made to our every-day affairs and the countless ways in which the apparently useless, although interesting, discoveries of science have increased productive power, raised the standard of living and shortened hours of labor. At the basis of present-day industrial development lies a knowledge of the laws and processes of nature, and below this lies the eternal inquisitiveness of the scientist who, working in his quiet laboratory, far removed from the bustle of world affairs, never ceases his investigations into the mysteries of nature.

To-day the voice can be carried over practically any terrestrial distance. In this advance the telephone repeater has played a dominant part. The repeater in its present form employs the three-electrode thermionic vacuum tube as the amplifying agent for telephone currents, and also includes balancing networks, electric filters, and means for controlling amplification, their association calling for great precision of design and manufacture.

The first and one of the most notable achievements, employing the thermionic telephone repeater, was the opening for public service, in 1915, of telephone lines between New York and San Francisco, a distance of some thirty-four hundred miles. In 1921, in order to cope with an increasing demand for transcontinental service, the loading coils were removed from the lines and twelve repeaters of an improved type were applied in place of the original six. This change made the circuits suitable for the application of carrier current facilities

and also resulted in a large improvement in the volume of transmitted speech. The four wires of the original transcontinental line now furnish three telephone circuits and, over certain sections, as many as twenty telegraph circuits. Since that date groups of northern and southern transcontinental lines have also been placed in service.

It was foreseen that ultimately the need for long-distance telephone service would require an improved type of circuit offering increased electrical stability, increased immunity from damage and disruption by storm, and also sufficiently compact physically to make it adaptable for very large densities of traffic. Accordingly, various lines of research were initiated for removing the restriction which had always limited the use of cable circuits to relatively short distances.

To date these researches have resulted in the telephone cable (over twelve hundred miles long) which has recently been completed between New York, Chicago and St. Louis at a cost of approximately $30,000,000. It supplies approximately two hundred and fifty telephone channels and five hundred telegraph channels. More recently a similar cable has been completed between New York and Cleveland via Albany and Buffalo at a cost of about $15,000,000. So satisfactory are long cable circuits proving from the standpoint of quiet and stable transmission that the program for 1928 contemplates the installation of some thirteen hundred miles additional.

Among the developments which are making these long cables possible are improved designs of cable and loading coils, improved methods for minimizing capacity unbalance, means for automatically controlling the amplification of repeaters as the resistance of the wire circuit to which they are attached varies with temperature, new and very compact types of telephone repeaters and other office equipment, and new systems of telegraphy. One system of land cable telegraph employs uni-directional line current of about one-twentieth the magnitude of the current employed in the standard grounded telegraph circuits; another known as "voice frequency" carrier telegraphy supplies twelve duplex channels in the frequency band required for a single telephone message. New systems

of loading designed to reduce "transient" and "echo" effects have also contributed to the success of the cable.

In this connection, it may be pointed out that whereas it has become economically desirable, as noted in a preceding paragraph, to remove all loading from certain long open wire lines nevertheless long cables depend upon loading because of their intrinsically higher attenuation properties.

One of the many novel developments underlying the successful long-distance cable is the "echo suppressor." In talking over very long cable circuits an appreciable interval of time exists between the uttering of the speaker's words and the return or reflected transmission or the "echo" to his ear from the distant end of the cable. This time interval is in the neighborhood of one-tenth of a second and early investigations showed that, to the average telephone user, appreciable echoes having such a delay are not only very noticeable but extremely confusing. The voice-operated echo suppressor was therefore devised automatically to restrict transmission on the circuit to one direction at a time.

From the earliest days of the telegraph and the telephone, there have been many attempts to develop methods for the multiplex transmission of messages employing relatively high frequency currents as "carriers." It was not until the development of the thermionic vacuum tube, however, that multiplex systems were brought within the realm of practicability. These tubes are used in carrier systems as repeaters or amplifiers, as generators of the different carrier frequencies, and as "modulators" and "demodulators" for respectively combining the messages with and separating them from the carrier currents.

These systems also extensively employ another important device which was given to the electrical art contemporaneously with the vacuum tube repeater. This is the electric wave filter. This remarkable device can be so designed as to select any predetermined band of frequencies, rejecting all others without absorption, somewhat as a prism will separate the various colors from sunlight. The rôle that the filter plays in carrier systems as a means of separating one message from another is therefore obvious.

Both carrier telephone and carrier telegraph systems have been extensively applied since 1918, primarily on open wire lines. When multiplexing a pair of telephone wires, it is possible and frequently economical to add as many as three or four high-frequency channels to the voice-frequency channel, thus increasing the message capacity of the wires either four- or fivefold. In the case of carrier telegraphy, the message capacity of a wire circuit may be made much larger and systems are in use in which as many as ten to twenty carrier-frequency channels are placed upon a single pair of wires.

A very simple carrier system which has just been perfected will make it economical to multiplex telephone lines as short as fifty miles.

Since 1911 the entire growth, if not the actual birth, of the radio telephone art has occurred. Like the developments in carrier systems this rapid progress has been largely due to the perfection attained in the design and manufacture of thermionic tubes. An early radio telephone achievement was the transmission of speech across the Atlantic Ocean in 1915 by American telephone engineers.

The development of radio telephone apparatus was undertaken during the Great War for such purposes as continuous communication between observing airplanes and artillery stations behind the lines, and between the units of a destroyer flotilla.

Following the war, public interest in the possibilities of radio telephony was quickly awakened with the consequent rise of broadcasting.

The development of radio telephony for commercial message uses may appear, in contrast to the rapid strides of broadcasting, to have lain dormant. However, notable progress is being made. Immediately following the war, the development of radio systems for establishing ship-to-shore telephone communication began. In 1920 the American Telephone and Telegraph Company demonstrated an experimental system which enabled a passenger on a ship several hundred miles at sea to communicate with any telephone subscriber on land through the latter's regular instrument. To accomplish this,

the message was carried over the water by radio and at a coastal station was relayed to any land line, which, in the case of one demonstration, was four thousand miles long. The system was entirely two-way in its operation in that it permitted the telephone subscriber and the person at sea to hold a conversation exactly as over the usual telephone circuit.

Thus far no very extensive installation of ship-to-shore radio telephony has occurred, largely because of numerous commercial questions.

Turning our thoughts back to 1915, we will recall that none of the now familiar aspects of radio telephony had put in an appearance. Radio telephony did not appear among the means of signaling employed in military operations until 1917; broadcasting was born about 1920.

The transatlantic radio demonstration of 1915 was purely experimental. On the one hand, it proved that a regular transatlantic telephone service was within the realm of possibilities, and, on the other, it provided the engineers who carried on the work a clear insight into the difficulties to be overcome before such a service could be offered. Between that date and January, 1927, when the opening of regular service was announced, there intervened an almost continuous program of study and development. The success of this work is well attested by the fact that the over-all efficiency of the radio link in the transatlantic telephone system is some thirty thousand times as great as it would be were it to employ the *best* types of radio apparatus used to-day in the broadcasting art. This figure of a thirty thousandfold increase of efficiency measures the contributions of the engineer and the applied scientist. It enables us to realize the manner in which the concrete problem of telephoning to Europe has yielded to the searching study of such investigators.

The difficult character of the technical problems involved may be gathered from the fact that, due to the extreme variability of atmospheric conditions as they effect the transmission of radio signals, the sending power required to produce a given effectiveness of received signal may increase by several thousand times within the space of a few hours. To insure even

reasonably reliable communication at all times of day and throughout all seasons of the year therefore necessitates transmitting stations of large reserve power and special receiving systems to reduce the interference arising from atmospheric disturbances.

Another difficult requirement to be met is that the transoceanic radio trunk must automatically relay messages to and receive messages from the wire lines in both Europe and America, so that it will be as easy for two telephone subscribers in each interior to converse as though they were located, one at each of the radio stations. To-day calls from Los Angeles or Seattle to the north of Scotland are handled as readily as those from New York to London.

What was probably the first continuous commercial use of the radio telephone occurred on the California coast where Bell System engineers installed wireless telephone equipment to establish a trunk line connection between the Island of Santa Catalina, which is thirty miles off the California coast, and the city of Los Angeles and thence to the rest of the continent.

Early in May, 1920, it was determined by the American Telephone and Telegraph Company, working with the Pacific Telephone and Telegraph Company, that it would be practical to establish telephone service to the mainland by making use of a radio telephone trunk between the wire circuits on the island and the Bell telephone circuits. Work was started at once and within two months the system was completed and in operation.

The studies showed, however, that service between the island and the mainland could in the long run be given more economically by means of a submarine cable than by wireless. But the manufacture of the cable required a considerable period of time during which telephone service was desired. After successful operation for about two years the radio system was dismantled and the cable cut into service.

The Catalina radio installation was notable also for its privacy or secrecy. By means of special distorting apparatus at each transmitter and distortion-correcting apparatus at the receivers, speech was transmitted in such fashion as to be un-

intelligible in broadcasting receiving sets. This proved to be a very desirable feature of the installation.

Early in the development of radio broadcasting, it was apparent that the popularity of programs would be greatly augmented were means available for bringing to the broadcasting station events of public interest such as large orchestral programs, sporting events and national ceremonies. This virtual extension of the walls of the studio by the use of telephone lines is now a matter of daily occurrence, particularly in America, as many as thirty or forty broadcasting stations being frequently joined together by a wire network to disseminate the same program. More recently it has been possible by use of the long-distance lines to provide a program, the different portions of which originate in widely separated cities.

A retrospective examination of the manually operated switchboard discloses that the trend of development has been toward a steady increase in the number of switching operations that are performed automatically, thus decreasing the time and effort required on the part of the operator for each connection and making for greater accuracy.

Early switchboards were so constructed that the presence of a calling subscriber was indicated by the falling of a little "drop," one of these being associated with each subscriber's line. During the progress of the call, it was necessary for the operator to restore the drop by hand. Hand ringing by the operator as well as by the subscriber was also an early characteristic of telephone calls. The switchboard lamp replaced the drop, and with it came a relay which automatically extinguishes the lamp when the operator plugs in to answer the calling subscriber. Lamps also came into use for supervisory purposes in connection with the cord circuits by means of which operators complete calls. One supervisory light is automatically extinguished when the called subscriber answers. Another supervisory light can be caused to glow by the movement of the switchhook to recall the operator. Upon the completion of the call, the operator—or all of them in case more than one have been involved—automatically receives disconnect signals indicating that the line is no longer wanted.

A recent automatic feature is ringing which continues until the called subscriber answers and an accompanying ringing tone telling the calling subscriber that the distant station is being rung.

Within the past few years, extensive installations of the dial or automatic telephone system have been made and here operators are required only to handle special and toll calls and to give information.

No better illustration of the coming importance of the dial telephone system can be had than that supplied by New York City. At present, there are over fifteen hundred thousand telephones in New York which are interconnectible through one hundred and forty-four central offices. By 1945, New York will have about three million telephones in service which will require about two hundred and seventy-five central offices. A system of two hundred and seventy-five switchboards and three million telephones in one city presents tremendous operating difficulties. Not only must arrangements be made to connect each of these telephones with every other one but also to connect them with more than a million telephones in the metropolitan area surrounding New York and many millions more throughout the country, to say nothing of foreign countries.

To attempt to handle the telephone needs of New York in 1945 on the basis of manual operation would involve two well-nigh insuperable obstacles. In the first place, more than fifty thousand operators would be required and careful studies indicate that the probable number of young women from whom telephone operators could be recruited would not be large enough to fill the needs of the business. This study shows that in 1945 there would not be enough girls coming from the high schools, giving due weight based on past experience to those girls who go into professions and other work, who go to college, who do not take up work upon leaving school and those having difficulty with hearing, sight, etc., to fill the demand for telephone operators.

In the second place, the rapid telephone growth and the multiplicity of central offices required would impose an impossible operating burden upon the telephone girls. As the

number of telephones and the number of central offices increase, it becomes more difficult for each operator to remember how to route calls from her office to every other office both in the city and outside. To attempt to do this manually throughout the years to come would tend both to restrict the telephone facilities of New York or other large cities and impair the quality of service due to unavoidable operators' delays.

Realizing as a result of a long view study of the future that this situation was destined to arise, the development staff of the Bell System was authorized some years ago to proceed with the development of a dial system which would be adequate to take care of such a telephone situation as that due to arise in New York a decade or so hence. Since 1922, the program of converting New York over to the dial system has been in progress and at present about 25 per cent. of all metropolitan telephones are of the dial type. The present program is to convert the city completely to a dial basis within the next ten or twelve years. This program will involve vast expenditures of money for new plants. At that time it is the expectation that instead of requiring more than fifty thousand operators, the need will be for between fifteen and twenty thousand, or about as many as there are at present employed in the city. It will, of course, be realized that the dial system does not eliminate the use of operators except on local calls, their services still being required for toll calls, information and other assistance calls. Similar programs of change are going on in practically every large city.

Over a long period of years, many schemes were proposed for the electrical transmission of pictures. Although these early systems were in most cases physically operative, none proved practical. To be of commercial value, a system must be at once simple, rapid and accurate. It has remained for developments of the last few years adequately to meet all of these requirements. In April, 1925, the first commercial picture transmission service, a development of the Bell Telephone engineers, was introduced embracing the cities of New York, Chicago and San Francisco, making possible the transmission of pictures in either direction between any of these points. The

actual sending time of a 5 x 7 inch picture is but seven minutes. At the sending end, the picture is required simply in the form of a positive transparency made by the ordinary photographic process, and after transmission it appears as a negative film from which prints can be produced without delay. As it is possible to transmit while the positive transparency is still wet, the over-all time of transmission is reduced to a minimum.

Since 1925, the system has been extended to embrace the eight cities of Boston, New York, Cleveland, Atlanta, Chicago, St. Louis, San Francisco and Los Angeles.

One of the most recent triumphs of telephone research and development is television. At the first demonstration given April 7, 1927, Secretary of Commerce Hoover while in Washington addressed and was visible to an audience of several hundred in New York City. Three distinct circuits were employed; one to convey Mr. Hoover's voice as in the usual long distance telephone connection, one to transmit the picture currents required by the television apparatus, and one to transmit the synchronizing currents needed to establish equality of speed between the rotating parts of the television transmitter and receiver.

Two forms of receiving apparatus were shown at that time, a type desirable for a small number of observers in which the speaker appeared upon a small screen a few inches square and one for display before a large group of spectators in which he appeared upon a large screen about three feet square.

The television apparatus is a natural outgrowth of certain researches which have been in progress at our telephone laboratories over a period of years and, of course, makes use of somewhat the same developments that underlie the transmission of pictures. Television, however, requires the transmission of a complete picture in about one-eighteenth of a second as contrasted with a period of seven minutes for the telephotograph apparatus so that it has involved an enormous speeding up of the optical and electrical processes involved.

Among the new magnetic materials developed for the purposes of electrical communications, two deserve special mention. One consists of very finely divided iron dust cemented

together under extremely high pressure to yield a material of substantially the same density as iron, of only one-twenty thousandth the electrical conductivity of iron, nearly the same initial permeability as iron, and yet, because of its finely divided ingredients and the consequent microscopic free poles distributed throughout it, possessing practically no residual magnetism even after exposure to strong fields.

The second new magnetic material, also a development of Bell System engineers, has been called permalloy. It is so sensitive to magnetizing influences that it is completely saturated in the earth's magnetic field, and is finding important applications in various kinds of telephone apparatus, notably in loading coils, as well as in submarine telegraph cables.

Research and development work such as has been involved in the perfection of switchboards, dial telephone apparatus, telephone repeaters, multiplex circuit apparatus, and the thousand and one improvements, great and small, which make the American telephone system the extensive and smooth-working machine it is to-day, is carried out in the centralized organization. This is maintained and financed by the American Telephone and Telegraph Company for the operating companies of the Bell System. The Bell Telephone Laboratories, the largest industrial laboratory in the world dedicated to the application of science to human needs, has a personnel of over thirty-nine hundred, more than half of whom are skilled engineers and scientists. Their work extends over much of the frontier of the physical sciences and into the realms of physiology and psychology.

It is out of these latter fields that such contributions to the afflicted as the artificial larynx and aids to the hard-of-hearing have sprung.

The program of centralized development which underlies the rapid progress of telephony in the United States was wisely begun by the founders of the business—the immediate successors of Alexander Graham Bell—half a century ago. While the duty of rendering local telephone service throughout the country was then, as now, allocated to local "Associated" companies, each having an exclusive territory, it was hoped from

the outset that instrumentalities would some day be discovered to make the telephone a nation-wide servant.

In anticipation of such a day the founders—realizing that the interconnection of telephones thousands of miles apart would presuppose identical electrical characteristics—provided that all research and development required by the Associated Companies should be conducted in a central organization, the results being made equally available to all. If, over a period of years, each company developed, designed and standardized its own apparatus, there would be little or no possibility of rendering satisfactory nation-wide service. The basis of nation-wide service lies in nation-wide uniformity of telephone equipment.

Europe to-day is struggling to liberate its many, and more or less incompatible, telephone systems from the bondage of dissimilarity. Such difficulties, by the exercise of foresight, have been avoided in the United States. It has been said that the telephone like the family circle is a natural monopoly. Had it not been for the centralized development of telephone equipment, the American telephone system would be a chaos rather than a great industrial nervous system extending throughout the nation.

Centralization has also extended to manufacture, to ownership of patents, and to ownership and operation of the long distance lines which tie the territories of the local operating companies together. All long distance telephone functions are assigned to a special department of the American Telephone and Telegraph Company, while the manufacturing division of the Bell System is known as the Western Electric Company. The purchase of materials for the entire System is also centralized in the Western Electric Company with extensive resultant savings.

Telegraphy is an older art by some thirty years than telephony. In use it is, like the telephone, expanding at an increasingly rapid pace although the total volume of business done and the total investment are now considerably smaller than that involved in the complementary art. The problems involved in the transmission of the dots and dashes or other

symbols of the telegraph code have not involved the same complex theoretical considerations as the telephone art but it too has effected notable improvements and economies particularly during recent years. Two of these have already been mentioned briefly, namely, the telegraph system employing a line current so small as to operate without interference over long telephone cables and the carrier current telegraph which by means of the multiplex principle makes possible the sending of twenty messages over a single pair of wires at one time. It is also possible to send telegraph and telephone messages over the same wires simultaneously, means, of course, being employed to prevent the intermingling of telegraph and telephone currents.

Another important telegraph development is the printer. By means of the keyboard sender and a typewriter-like receiving apparatus, messages are now sent over any distance and printed as received. Printer equipment is finding extensive use privately as well as for the transmission of paid messages. It is, for example, proving the most satisfactory means of conveying information between executive headquarters and factories in the case of companies where these are located at some distance from each other.

It is also used extensively in the newspaper world for the distribution of news. With a printing telegraph in each newspaper office, it is possible to loop fifty to one hundred offices together on a single circuit so that they can all be supplied simultaneously with the same "copy." As this is received in typewritten form, it can be quickly edited and turned over to the composing room.

The printer telegraph makes use of code characters of uniform duration, in distinction to the familiar characters of the "Morse" and "Continental" codes. The development of this code by Baudot—a two-element, five-unit code—although not a new achievement, is more extensively applied to-day than ever before.

The art of submarine cable telegraphy has also undergone a most notable change in the past few years. The development of the new magnetic material permalloy, referred to in an

earlier paragraph, placed in the hands of the communication engineer a material which for the first time could be used to continuously load a submarine cable. Working in collaboration with the Bell Telephone Laboratories, the Western Union now has transatlantic permalloy cables whose message capacity is each above five times that of the old style non-loaded cable. The permalloy cable also possesses the advantage that printing telegraph equipment can be worked over it.

XXIV

COMMERCIAL ASSOCIATIONS

By John H. Fahey

Past President, Chamber of Commerce of the United States

FEW institutions have had a greater influence on the remarkable development of American business and industry during the last century than the organizations formed by business men for the purpose of exchanging the results of their experience, improving methods, securing better laws and aiding civic progress. These organizations have multiplied in numbers and increased greatly the scope of their activities in step with the steady development of the country. In recent years, especially during the last quarter of a century, their development has been marked by broader vision, greater public spirit and new conceptions of the responsibilities of business men to their communities and to the nation. In the cities there has been a very marked gain in the interest of these organizations in civic questions in addition to purely business problems. In the comprehensiveness of their work as well as in numbers, methods of operation and effectiveness these business men's organizations represent at present the peak of their development in the United States and compare with the best of their kind in the world.

Commercial organization had its beginnings in the United States before the foundation of the Republic. Though limited in numbers and dealing with comparatively few subjects the associations of business men in New York, Philadelphia and Boston in colonial days were representative and influential. The meeting places of these organizations in that period, and indeed for nearly half a century, were usually in taverns and

coffee houses and action was taken on questions presented to these bodies only in monthly meetings of the members.

While difficulties involving shipping occupied a large part of the attention of such organizations during the colonial period, they also developed useful systems of arbitration and sometimes attempted the regulation of prices. The New York Chamber of Commerce, for example, the oldest institution of the kind in the United States, in its early days not only considered methods of fixing the price of meat and cartmen's wages, but it also concerned itself with civic affairs and formulated plans for keeping the streets of the colony clean.

The few organizations of business men in existence at that time practically disappeared during the Revolution, and from the establishment of American independence until the Civil War the evolution of these associations was slow. Then the advent of the railroad and the telegraph with their quickening influence on commerce gave a new stimulus to the movement for the formation of business men's organizations. The Civil War interrupted this development and it was some years after the end of that conflict before they began to be a really important force.

Somewhat indefinite records indicate that just before the Civil War there were in the United States about thirty organizations of business men worthy of notice. Of these, ten were Chambers of Commerce and twenty Boards of Trade. Their functions and methods were much the same and the differences in names were of no significance. At the end of the Civil War most of these institutions were more or less moribund, but in the thirty years following, new ones sprang up and old ones took on new life all over the country. The movement for organization of the business men for the promotion of their own interests and those of the communities in which they lived spread from the cities to the towns and then influenced the formation of state and regional associations as well as national trade associations. By 1898 there were in existence 2,944 local Chambers of Commerce and Business Associations and over 100 national trade associations. There

was also a movement toward national organization of business men intended to deal with national problems. Three such associations made their appearance, the National Business League, the National Council of Commerce and the National Board of Trade. All were federations of local and state associations and national trade associations. But the membership of the National Business League and National Council of Commerce was more distinctly individual.

It was quite natural that the enthusiasm for organization which brought about the rapid evolution of these thousands of business men's associations in the comparatively few years up to 1900 should result in some weaknesses and cause certain reactions. In many directions organization was overdone. In the larger cities several rival organizations were often formed, with the result that their energies and resources were divided, and because of jealousies they often took opposing sides on important questions of public policy affecting business, thus causing confusion and conflict instead of promoting harmony. Then, too, the forms of organization were often defective and became the subject of criticism and reform. In many instances authority for expressing the views of large numbers of business men on debatable questions was concentrated in the hands of a few directors, which encouraged unrest and complaint. Again, methods of selecting officers and directors were such as to invite claims that these officials were employing the machinery of the organization to keep themselves in office and control its decisions. With the general demand for improved business methods, and more study and discussion of business problems which these organizations themselves were encouraging, there soon came a demand for new forms and more efficient plans of operation for the organizations themselves. In the larger cities especially, business men became disgusted with the petty quarrels of organizations and the waste of resources represented by local rivalries. A new movement toward consolidation, greater democracy and better methods began about 1893 under the leadership of some of the midwestern cities. The Cleveland Chamber of Commerce was the first to demonstrate the value of new ideas, Chicago acted

energetically soon after and Boston and other eastern cities followed their example and reorganized their business associations within a few years. In many of the larger cities by the time this reform movement began there were Chambers of Commerce, Boards of Trade, Merchants Associations and Commercial Clubs as well as other business bodies of similar character operating competitively. Reorganization plans generally took the form of bringing all of these associations in a city together in one association. The effect was to reduce overhead operating expenses, increase the revenues available for research and expert assistance, make possible the organization of new bureaus and the extension of many former activities.

This development in the leading cities, which later had its reaction in the smaller communities, represented in many respects a distinct departure from American conceptions of business organization a quarter of a century earlier. The theory of the organization of the preceding epoch was that the conclusions of business men with reference to great public questions, reached as the result of an exchange of opinions in a monthly meeting, were of great value in the determination of policies or the promotion of more successful methods of conducting private enterprise. As the operations of commerce began to take on new complications, however, and the demands on the time of business leaders increased, they did not have sufficient opportunity to study the problems concerning which they were expected to express views. As a result more efficient and thorough plans for conducting the work of business men's associations were called for and the attitude of thoughtful members toward their associations underwent important changes. It soon came to be realized that offhand opinions on business questions were too often superficial and not especially valuable. New methods of organization, therefore, contemplated investigation of important questions by competent experts under the direction of carefully chosen committees, reports on the results of their deliberation to a Board of Directors and usually thereafter to the membership for discussion and disposition in general meetings. This improvement in

methods and consolidation of competing associations soon established greater respect for their conclusions and recommendations on the part of the public at large as well as municipal, state and national government.

As an incident of the reorganization movement the consolidated associations of the larger cities usually created a series of departments or bureaus which had oversight of certain activities, for example, transportation, credit information, harbor development and shipping, industrial development, retail trade, foreign trade; and civic development. Many committees are to-day related to these general departments in the modern Chamber of Commerce. They deal with everything touching business, from postal affairs and transportation by air to arbitration conventions and Daylight Saving. Their activities in the civic field represent one of the outstanding developments of the present era. In most of the large cities and a large proportion of those of smaller size they interest themselves in city planning, traffic regulation, street improvements, health and sanitation, education and nearly everything touching the welfare of the community.

The movement for better organizations of business men which has been so conspicuous in the last twenty-five years has not been confined to the large cities. It has extended to the smaller communities, with general acceptance of the principle that associations of this character cannot be truly successful without the services of paid executives who give all their time to the work in coöperation with the business and professional men. Where associations are so small and so limited in resources as to be unable to maintain a professional secretary, they frequently employ a part-time executive, and the methods of operation are in many respects similar to the associations of the larger cities although on a more modest schedule. The influence of the smaller business and trade associations in the moderate-sized cities and towns of the country has increased very greatly as a result of better organization.

A feature of the activities of all of these local business men's associations which has had an interesting reaction in recent years has been the periodical luncheon or dinner meet-

ing of members. Usually these meetings are planned weeks and months ahead and interesting speakers, expert in their fields, are brought from afar to address the membership on important public questions. The result has been widespread exchange of ideas and the steady education of business men in all parts of the country with reference to their own problems. In the larger centers also another incident of development has been the publication of weekly or monthly magazines or bulletins employed not only to chronicle activities of the organization but to promote education on business questions.

The recent improvements in the organization of purely local associations and the increase in their effectiveness has been paralleled by corresponding developments in state and regional associations of manufacturers and national trade associations. There are now more than twenty-five state associations of manufacturers. State Federations of Chambers of Commerce have increased rapidly and the growth in the number of national trade associations of which there are now more than five hundred in existence has been very marked. In nearly all these associations the same theory of better organization has developed and the necessity of employing trained secretarial assistants recognized.

According to the latest figures available, the number of commercial organizations in the United States has more than doubled in the last thirty years. The figures at present are as follows:

Chambers of Commerce and similar organizations	6,499
State Organizations	1,130
National Trade Organizations	1,199

With the extraordinary growth of American foreign trade in recent years there has been a corresponding increase in the number of American commercial organizations located in foreign lands. There are now over thirty American Chamber of Commerce organizations in different parts of the globe. The American Chambers located in London, Paris, Berlin and Milan are the largest and most successful. A number of associations of this character in South American countries and in

the Orient are, however, well organized and have substantial memberships.

Many of the national trade associations have had a far-reaching influence on the simplification of standards, the elimination of unnecessary types, the reduction of waste, better cost accounting and better sales methods within their own trades. Their achievements in these directions have brought about improvements in distribution in the United States on a scale which is but little understood. The associations of this type in our country easily lead the world.

The local and regional development of Chambers of Commerce and business men's associations and evolution of better organizations reached a logical and consistent climax in 1912 in a demand for better national organization. As the local associations increased in efficiency, coincident with the rapid development of the commerce of the country, they found that many questions of grave importance which they were called upon to deal with were national in character. Soon it was apparent that as they acted individually on national questions and sent their representatives to Washington to express their views to Congress there was great divergence of opinion, as a result of which business expression did not command great respect among the leaders of the national government.

The national associations of business men which were in existence up to 1912 suffered from the same reaction as the local associations which were found to be insufficient for the needs of the day. Local and sectional jealousies among the organizations were such, however, that a number of efforts to bring them together in one comprehensive national organization failed. It was not until President Taft and Secretary Nagel, of the Department of Commerce and Labor, called a general conference of delegates representing all types of business associations in the country in the spring of 1912 that really effective steps were taken toward the creation of a representative national federation of the business interests. Out of this conference came the appointment of an organization committee which within a year formed the Chamber of Commerce of the United States. In the fifteen years which have since intervened

this association, broadly democratic in character, has grown from less than 100 organization members to about 1,579. This membership represents at present something over 850,000 business firms and individuals. This federation consists not only of the local and state organizations of business men but of 600 national trade associations and 19,702 individual members. It is organized in a series of great departments dealing with transportation, finance, manufacture, agriculture, civic affairs and every other type of national activity touching the development of commerce directly or indirectly. Each department has its own manager and a competent staff. There is an Advisory Committee of business men for each of these bureaus and scores of special committees operate under the auspices of the Board of Directors with the aid of staff experts. The Board of Directors is chosen directly by the membership, while there is also a National Council consisting of one representative from every local, state and trade organization.

Action on public questions may be taken at annual meetings of the Chamber, but a referendum system has also been developed which has proven exceedingly useful and which is employed in the intervals between annual meetings. The organization cannot be committed on any public question except by action of the membership. In addition to the maintenance of a handsome national headquarters in Washington, completed in 1925 at a cost of three and a half millions of dollars, the Chamber of Commerce of the United States maintains branch offices and secretarial staffs in New York, Chicago, Dallas and San Francisco. It publishes a monthly magazine—*The Nation's Business*—which has a circulation of 250,000, and the Chamber employs a staff of 375 persons. Its annual budget for its regular operations now amounts to approximately a million dollars.

The Chamber of Commerce of the United States as at present constituted, the largest and best organized institution of its kind in the world, may be taken as a reflection of the growth in numbers and efficiency of American business organizations generally.

The demand for more scientific knowledge of business problems and better methods of dealing with them has had an interesting reaction in the rapid increase in the number of men who have undertaken commercial secretarial work as a profession. Several universities have now established courses intended to train men for this profession. There are several sectional associations of commercial secretaries, one national organization, the National Association of Commercial Organization Secretaries, with a membership of 1,000, and another of the trade organizations, the American Trade Association Executives, which has 167 members. With the support of the Chamber of Commerce of the United States and many local associations a national summer school for commercial secretaries has now been established at Evanston, Ill. At the 1927 session of this school there were 250 students in attendance.

The greater strength and effectiveness of all types of associations of business men in the United States in recent years and the new and more important relations which the country has developed with other nations of the world has had the logical effect of increasing greatly the interest of American business organizations in international questions. As a result the Chamber of Commerce of the United States representing all the business and financial interests of the country has had an important part in the reorganization of international business coöperation which became necessary after the war.

American organizations together with those of forty other countries were members of the International Congress of Chambers of Commerce and Commercial and Industrial Associations which was in existence for a dozen years before the World War. It was destroyed by that conflict and it became impossible to reëstablish it when peace was declared. Moreover, with the general improvement in the type of business organizations it was apparent that international federation would have to assume a more modern form. Steps in this direction were taken under the auspices of the Chamber of Commerce of the United States when an International Trade Conference was called in Atlantic City in 1919. As a result of that meeting an organization committee was appointed to form the In-

ternational Chamber of Commerce under the leadership of the allied countries. The plans of organization were approved in Paris the following year. Soon thereafter the membership was opened to all countries, and the institution has now grown to the point where it includes in its membership more than forty nations.

Following the lines of better organization demanded everywhere during the last two decades, the International Chamber of Commerce has established a permanent headquarters in its own building in Paris with a large paid secretarial staff and constant representation at this central bureau of commissioners from each of the important commercial nations of the world. The International Chamber of Commerce operates along lines similar to those of the Chamber of Commerce of the United States, which in turn reflects methods which have been found effective and necessary not only in the larger cities of America and Europe but in the smaller communities as well.

It has had an important influence on the adjustment of the war reparations problem, inter-allied debts and the reduction of trade barriers. It had an important part in the World Economic Conference in May, 1927, when for the first time in history an independent organization of the business interests was invited to join with the governments in a conference of this character and it has repeatedly been represented in the various conferences called by the League of Nations to deal with economic questions.

XXV

MAIL ORDER MERCHANDISING

By Julius Rosenwald

Chairman of Board, Sears, Roebuck & Co.

THE mail order business is founded on the inherent desire of the average person to buy dependable merchandise at less than ordinary retail prices. This is not confined to the thrifty alone; it is virtually universal. The mail order business meets that desire, having as its creed not only lower prices and better quality, but absolutely square dealing and a sound guarantee of satisfaction. Hence its astonishing success.

The business was born about a half century ago. For a few years it struggled fitfully, then improved manufacturing methods began to produce better and better merchandise at lower cost. Meanwhile scientifically worked out systems were making it increasingly easy to handle, pack and ship vast quantities of merchandise with precision and dispatch and at a minimum of expenditure.

It was not until some twenty-five years ago that the mail order business finally came into its stride. Since then its growth has been phenomenal. To-day one house alone has more than eleven million customers on its books, fills more than thirty-five million separate orders a year, and, in 1926, did a gross business of more than two hundred and seventy-two million dollars.

The business shows steady increases year by year as more people come to recognize the intrinsic merit, the safety and the comfort of this way of shopping.

The accomplishments of the mail order business are manifold.

It has materially reduced the cost of living for millions of

people in the United States and Canada and, in a limited way, in some foreign countries.

It has been one of the biggest factors in establishing the principle of one price to all.

It was the originator, as it has since been a staunch supporter, of a positive guarantee of satisfaction to the purchaser as to the value and the quality of his purchase. This guarantee makes the customer the sole judge, accepts his decision and returns his money, or exchanges his goods, as he may elect.

So thoroughly stabilized has the business become that the catalogues of the larger mail order houses are to-day, to a large extent, the price standards of the country.

In many other ways the mail order house has operated actively to promote honest merchandising. Here are two specimens: It was foremost in eliminating misleading names of furs and in setting forth clearly the name of the humbler animal which was frequently masquerading as of the fur nobility. It led the world in classifying with exactness wool and silk mixtures to show just how much wool and how much silk was joined with cotton in materials and wearing apparel. "Wool mixed" and "silk mixed" long ago disappeared from mail order catalogues, to be replaced by "half wool," "about two-thirds pure silk," etc., etc.

It was a pioneer in, and an intense partisan of, "Truth in Advertising," that movement which has largely wiped out general advertising misrepresentation.

Self-interest as well as lofty motives placed the business on this high moral ground. Obviously, where there is no personal contact of buyer and seller, where the customer buys from illustrations and printed descriptions alone and pays cash in advance, the business to be successful must be founded upon truth on the one side and confidence on the other. No mail order organization can succeed which abuses that confidence. None can prosper unless in its catalogues picture and description are absolutely truthful and present a true image to the mind of the customer. Exaggeration and over-description find no place in a catalogue of the modern successful mail order house.

This was not wholly true in the early days of the business. In fact a multitude of individuals and firms has risen up, flourished for a time on misrepresentation and fallen into oblivion. They would perish as inevitably to-day because dishonesty cannot possibly survive in this field.

More than mere passive honesty is shown by the better and bigger houses, at least in the precautions they take to safeguard their customers even against themselves. They refuse to catalogue and sell merchandise which is harmful or against public interest, or which may be diverted from a normal to a hurtful use. For example, pistols and revolvers are no longer found in the catalogues of the larger mail order organizations.

So with patent medicines. The mail order house found them an immensely profitable line. Yet, analysis a few years ago developed that many of them were not only of no benefit, but, on the contrary, were actually harmful, some even containing habit-forming drugs. So the entire list was abolished. To-day the only medicines catalogued are those which are officially approved by the leading drug and medical associations of the country.

In other lesser and yet important ways the mail order house serves its customers, particularly those living far from metropolitan centers. The catalogue, with its thousands of items of merchandise, from all parts of the world, of every conceivable sort and in bewildering variety, is a veritable encyclopedia. It actually serves as an authentic work of reference in many schools. It keeps isolated people up to date in lines which change with the seasons, or which are constantly being improved, such as wearing apparel, automobile accessories, radio, phonographs, and many others.

In short, it brings the world to every village, every hamlet, and every farm in the country, as well as to the homes of myriads of city dwellers. It entertains and instructs on the one hand, while it invites savings on the other.

As I have said, in its early history, the mail order house was not so meticulous in the matter of truthful descriptions, or in dealing with entire frankness and fairness with its customers. It inherited from the merchandising methods of the

time that buccaneering slogan: "Let the buyer beware!" And a lot of sharp practices crept in. Yet, the customers of that day, being themselves brought up with the same viewpoint, were accustomed to be on the alert to protect themselves. So, in spite of the lack of complete coöperation and confidence, the business went along quite comfortably, if slowly, for a considerable period.

Gradually, however, the idea began to take form that it might be profitable to avoid exaggeration in catalogue descriptions and set forth the unvarnished facts about the merchandise. It was profitable. Returns were reduced; correspondence was reduced; sales increased. A mighty truth had been discovered!

Presently one of the great minds in the industry conceived the idea that it would be novel, if somewhat adventurous, to assume the customer to be honest, even as the mail order house had become, and to trust implicitly in that honesty. The author of this departure from accepted beliefs, Richard W. Sears, founder of Sears, Roebuck and Co., was warned that this was pure commercial suicide; that people generally were not honest if they could be dishonest and not get caught; that they would take instant and frequent advantage of the house that gave them such an opportunity. Nevertheless the experiment was tried, in the form of advertisements offering to send merchandise out for approval before the customer sent any money, and it succeeded tremendously. That plan has since been largely abandoned and other sales propositions have replaced it. These, however, also offer an honesty test. The first departure definitely established the conviction that most people are honest, a conviction which the mail order business has since borne out conclusively. The losses from dishonesty are so small as to be virtually negligible.

The same outcry was raised when the first of the present broad guarantees of satisfaction or money back was adopted. The guarantee of Sears, Roebuck and Co., which is substantially that of other reputable mail order houses, reads as follows:

We guarantee to save you money; to deliver all merchandise safely; to satisfy you perfectly.

We guarantee that every article in this catalogue is honestly described and illustrated.

We guarantee that any article purchased from us will give you the service you have a right to expect.

If for any reason whatever you are not satisfied with any article purchased from us, we want you to return it to us at our expense.

We will then exchange it for exactly what you want, or will return your money, including any transportation charges you have paid.

It will be seen that this leaves a tremendous opportunity for people disposed to be unscrupulous. It seems to open the way for a man to order a suit of clothes, wear it for a month or two, tire of it and send it back for credit or exchange. It would appear that the rural sportsman may buy a shotgun at the beginning of the open season, use it to his heart's content and return it after the season is closed and get his money back. Yet rarely does this sort of thing happen. That may be from fear of detection. I believe, however, it is the simple inborn integrity of the average individual.

As a matter of ordinary business routine, records are kept of returned goods as well as of sales and when it happens that some individual is clearly trying to take advantage of the house, his record is carefully checked. If the case against him is fairly proved, all subsequent orders from that individual are returned unfilled. This is the only penalty sought or inflicted, but in its effect it is, after all, a severe one.

The mail order house, therefore, has definitely demonstrated this great commercial principle—that it pays to play fair; that it pays to give perhaps a little *more* than is promised rather than a little less; that it pays to believe in the honesty of our fellows.

Following the blazing of the trail by the mail order industry, it appears that this principle has been receiving encouragement generally throughout the commercial world. More and more those who have been inclined to take advantage of their customers when the opportunity occurred are becoming convinced

that the idea is unsound and unprofitable. An instance which arose not long ago aptly illustrated this. A certain house which has been in business a great many years, and which was esteemed as highly successful and thoroughly reputable, formed a connection with one of the larger mail order houses. Now, as is natural and logical, this mail order house insists upon as rigid a virtue on the part of its associated concerns as it maintains in its own dealings. And before the expiration of the first year of this association, one of the executives of the outside organization made this statement:

"You have completely revolutionized our methods during the past twelve months. We always believed we were conducting our business in a perfectly proper way and would have been highly indignant had we been told otherwise. Yet we have discovered, since this close observation of your methods, that we have been doing nothing of the kind. We have always taken a certain advantage of our customers in what has been considered a right and proper manner in our trade and we did not realize the impropriety of it until we saw how you dealt with the matter. The contrast was painful. Although we expected to lose money by doing it, we reformed. And our profits became steadily greater! We have found the great truth that you in the mail order business evidently discovered years ago—that it pays to be absolutely honest—pays in dollars and cents. Or, as some one has said, 'It pays to be honest. I've tried both ways.'"

Another interesting example occurred recently involving a manufacturer of world-wide reputation whose product is advertised and sold everywhere and is generally accepted as being of highest rank. This manufacturer undertook to make for one of the larger mail order houses a product similar to his own and the equal of his best. Within six months after this association commenced, an official of the company said:

"We have acquired a new respect for the mail order business. We believed that we were taking as much pains as it was possible to take in our factory to produce a perfect product, but since we have taken over the contract with you and have observed the ceaseless and intensive thoroughness with

which you have inspected the work all the way through and have seen how your practical suggestions as to processes have bettered even our own best, we have revised our methods to follow yours. Because of this association with you, we are to-day making better goods than we have ever made—better even than we thought it possible to make."

As we have seen, the first great economy effected by the mail order houses is the elimination of the middleman in the buying of merchandise. Almost without exception, they buy direct from the factory and sell direct to the user. The big houses buy in vast quantities, and for cash. They not infrequently take over the entire product of a factory. They place huge orders with factories during their otherwise slack seasons, cutting costs still more. Where they find that they can more advantageously manufacture the article themselves, they are prepared to do so. The smaller houses, of course, cannot avail themselves of all these ways of reducing costs, but they all, to a certain extent, employ the same means to the same end.

In the operating methods also great economies are brought about, especially in the larger mail order houses, in the handling, packing and shipping of merchandise. The famous Schedule System originated by Sears, Roebuck and Co., and which may be accepted as the latest development, moves with the smoothness and exactness of a precision instrument. It has been refined and improved throughout the years until to-day it is as near 100 per cent. efficient as a system can be.

Orders to the mail order house correspond to customers in the retail store. But, the mail order house has a great economic advantage in that the number of orders (or customers) at any given time of the day can be controlled. At Sears, Roebuck and Co., orders are scheduled every ten minutes, the quantity depending upon the number received during the day. This varies greatly with the seasons. Thus, they have an uninterrupted flow of business which is the same at eight o'clock in the morning as it is at any other period of the day, and the rush hours and slack periods experienced by retail stores are eliminated.

Orders move through the various departments of the house

all day long, and in rush seasons far into the night, on this ten-minute schedule. That is, an order which is received at, say, eight o'clock in the morning may be scheduled to be shipped ten minutes after one that afternoon. At precisely 1:10 P.M. that merchandise is in the shipping room being packed. A few minutes later it is on its way to the customer along with thousands of other orders scheduled for the same hour and minute. The 1:10 shipments out of the way, the packing room occupies itself with those scheduled for twenty minutes after one, but not a 1:20 order is touched until every 1:10 is disposed of.

How is it possible to determine at the beginning of the day just how many orders the various merchandise departments will be called upon to handle? And what makes possible the twenty-four-hour service which fills and ships ninety-nine out of every hundred orders within twenty-four hours after they are received?

First is the even, uninterrupted flow of orders to the merchandise departments, which prevents an overload one hour and a slack time the next. This distribution is based on the immutable law of averages which, in this instance, is determined over years of experience.

Sears, Roebuck and Co. receive at all their stores from 3,000 to 8,000 pounds of first-class mail a day—from one and one-half tons to four tons—which is made up of 165,000 to 440,000 letters. Before the mail is taken out of the sacks, it is weighed and from that weight the company can determine with sufficient accuracy for all purposes how many orders have been received.

They know that a thousand pounds of mail will average 55,000 letters; that out of the 55,000 letters a certain percentage will contain orders; and that the balance will be given up to miscellaneous correspondence. They also know from past experience what the percentage of orders received before nine o'clock is as compared to the total orders that will be received for the day. Therefore, by weighing the mail received and deducting miscellaneous correspondence, they can very easily determine about how many orders will be received that day.

And, by multiplying the number of orders received by the average value of the order, the sales for the day can be quite accurately determined by nine o'clock A.M.—all from the bulk weight.

The average value of orders, of course, varies with the seasons, but past experience has given the mail order houses a very accurate chart of what this seasonable variation is. With this knowledge at the beginning of the day and at intervals throughout the day, it is possible to fix shipping times and pass the orders along to the various merchandise departments at a rate which will keep them running easily and steadily without hitch or break.

Then, machines and mechanical aids of every possible sort are employed. Man power is eliminated wherever a machine will do the work better and quicker—particularly quicker. Machines open the mail at the rate of 450 letters a minute, at the same time stamping the date on the envelope. Pneumatic tubes, endless belt conveyors, chutes, electric trucks take over the distribution of orders to the merchandise departments and the handling of the merchandise thereafter.

Supplementing all this is the high specialization of head and hand work. One corps of employees does nothing but remove letters and orders from envelopes. They pin the checks and money orders to the order sheets and letters which they accompany. Another group tallies the amounts sent with the orders, notes the amounts on the orders, detaches the remittances to be sent to the cashier's office, and passes the orders to another division. Here the orders are sorted by still other highly expert people, recorded and finally distributed to the merchandise departments. All work with a truly incredible rapidity. Speed, speed and more speed! But never at the cost of accuracy.

Sears, Roebuck and Co.'s Chicago house is divided into sixty-six distinct merchandise departments, such as furniture, piece goods, hardware, phonographs and pianos, hosiery, stoves, etc., etc. These are scattered over about ninety-seven acres of floor space in the huge buildings which house them. A single order from a customer may call for merchandise from

perhaps ten of these departments. The problem then is to bring the merchandise from each of these ten departments into a certain section of a certain shipping room at a certain hour and minute in order that they may be packed together, where desirable, or at least shipped simultaneously.

Let us say there is such an order on ten departments. Expert typists have drawn off on ten separate sheets the orders for each of the ten departments involved. These sheets are sent by pneumatic tubes to the departments, where trained stock men and order fillers take them in hand. Carefully checked and rechecked to avoid mistakes, the merchandise goes by chutes, endless belt conveyors and other mechanical devices to that part of the particular shipping room designated. From all ten departments it arrives there by 10 A.M.—not more than twenty minutes before—not one minute after.

Everywhere is system, precision, intelligently applied energy. There is little room for lost motion anywhere. There are no idle clerks waiting for customers, nor taking time to explain, describe or sell.

Thus, throughout the entire system—buying, handling, shipping—substantial savings are made of time and money. And these are reflected in the low retail prices found in the catalogue—prices possible under no other plan of merchandising.

It would appear that the first definite and concerted effort to secure retail sales by mail was made in 1872. For the previous year or two farmers in various parts of the country had been organizing Grange Alliances and similar associations among themselves, the primary intent of which was collective buying.

The movement was not long lived, but it was sufficiently active to attract the attention of A. Montgomery Ward, a Chicago dry goods buyer who had been a traveling salesman. Mr. Ward was a keen trader. He knew his merchandise and he knew people. He conceived the idea of meeting this demand of the farmers for lower retail prices by inducing them to buy from printed lists instead of over the counter. Thus he constituted himself the sole factor between the manufacturer and the consumer, eliminating jobber, manufacturer's agent, or wholesaler, and salesmen, with their expenses and profits, and

sharing this saving with his customers—the very essence of a large part of the economies which the mail order business has evolved.

With his brother-in-law, George R. Thorne, Mr. Ward established the firm of Montgomery Ward and Company, in Chicago, in 1872. The first merchandise offered was dry goods, a line with which Mr. Ward had been long identified. It was offered on a single sheet of paper containing perhaps fifty items, the highest price being $1.00. Gradually, however, other merchandise was added until a fairly general stock was offered in later catalogues, which became more and more voluminous.

To-day its catalogue has more than 700 pages, 9¼ inches by 13¼ inches, and shows thousands of items.

The business grew slowly, being handicapped by inadequate manufacturing facilities, the lack of comprehensive and cheap transportation and the halting development of means of communication. Nevertheless it grew because it met a popular need and effected a sound economic gain.

By 1887 it had shown substantial progress and from then on expanded more rapidly. To-day Montgomery Ward and Company are the second largest general mail order house in America, with branches and warehouses all over the country, and doing business in every state of the Union, in Canada, Mexico, South America, the Far East and many other foreign parts. Its gross sales for the year 1925 were one hundred and eighty-four million dollars; for 1926, nearly two hundred million dollars.

The largest general mail order organization in the country is Sears, Roebuck and Co., also with headquarters in Chicago. It has additional mail order distributing plants in Philadelphia, Kansas City, Minneapolis, Memphis, Atlanta, Dallas, Los Angeles, Seattle and Boston, and distributing warehouses in many other parts of the country. The company does practically no selling outside the United States and its island possessions.

The founder of this organization was Richard W. Sears, who, in the early eighties, at the age of seventeen, realized the

possibilities of the mail order business and began selling watches by mail. He was at the time local agent for the Minneapolis and St. Louis Railroad at Redwood, Minnesota. His venture was startlingly successful and he shortly moved to Chicago to secure a more central location. There he organized the R. W. Sears Watch Co. Eventually he sold out his business and not long after again joined forces with A. C. Roebuck, who had been associated with him in the watch company. In 1893, the name Sears, Roebuck and Co. was adopted.

The first Sears catalogue of general merchandise contained less than 300 pages, 6 inches by 9 inches. The current book has more than 1,000 pages, 8½ inches by 11 inches, showing over thirty-five thousand items. And its gross sales for 1925 were more than two hundred and fifty-eight million dollars; for 1926, over two hundred and seventy-two million dollars. It is estimated that the sales will exceed two hundred and ninety million dollars in 1927. It has the names of more than eleven million customers on its books.

Thus these two leading houses did an annual business in 1925 of upwards of four hundred and forty-two million dollars; in 1926, of about four hundred and seventy-two million dollars; and will do approximately five hundred million dollars in 1927.

From the magnitude of the business and its steady growth, it is evident that the mail order business is indubitably a vital factor in the commercial life of the nation and one which is each year playing a more important part.

XXVI

MOTORIZING THE WORLD

By John N. Willys

President and Chairman of the Board, Willys-Overland Co.

THE sensational growth of the automobile industry during the last thirty years is the outstanding transportation achievement of modern times.

Although still an infant in point of years, the industry outranks any other in value and volume of output and sales and exercises an economic and social influence of major importance.

It introduced mass production and mass merchandising on a scale never before known; revolutionized machinery; and its mechanical progress is one of the marvels of modern engineering.

By aiding the development of other basic industries; by giving employment directly and indirectly to more than 7,000,000 persons and by providing many millions of people with a ready, cheap means of rapid transportation, the automobile has made America the industrial leader of the world and created a prosperity that is almost without parallel in human history.

Viewed in true historical perspective, the youthfulness of the industry can be appreciated by the fact that many of the men who pioneered the automobile are still living and active in its leadership. They had the vision to foresee that the "horseless carriage" was imminent and that it would prove to be one of the greatest developments in transportation history.

How true this is may be gleaned from the fact that up to the beginning of the nineteenth century, transportation practically had stood still for thousands of years! Consider the astonishing thought that while enormous advances were made in other

branches of science and art, exactly the same mediums of travel were available from the time of Christ to the days of George Washington. It was not until 1769 when Watt invented his first steam engine that hopes and experiments were inspired to devise a new type of vehicle and it was several years later before even steam was successfully applied to transportation.

When Sir Isaac Newton, centuries ago—long before Watt—predicted that man would "travel at forty miles an hour," his contemporaries declared him insane, but even Newton—one of the greatest scientific minds the world has ever known—doubtless had no conception of the tremendous speed and the fast, automatic machinery which the present age presents.

Man to-day is traveling at a rate many times the speed Newton dreamed about and is no longer particularly startled or impressed by a ground velocity of 120 miles an hour. Although Newton was the first on record to be very specific about the rate of travel, there were others long before him who seemed to visualize the automobile. Roger Bacon, the English philosopher and man of letters, said that "it will be possible to construct chariots so that without animals they may be moved with incalculable speed." Even the Grecian mythologists speculated on unknown mystic forces which would carry men through space and over the ground at speeds comparable with shooting stars and the swift movements of the pagan gods.

Contrary to popular conception, the automobile did not have its origin in America, although Americans were destined to develop it later to a greater extent than any other nation. The "horseless" vehicle idea first gripped the minds of inventors in France, Germany, Austria and England, and their experiments led to some important discoveries during the nineteenth century. It is interesting to note, too, that the engines used to propel these carriages passed through the stages of steam, street-lighting gas and electricity before the gasoline motor was invented and applied.

The first automobile or mechanically driven vehicle on record was developed by a French captain of artillery in the French army by the name of Cugnot. Cugnot was trying to apply speed to moving heavy cannon. After spending years in mak-

ing engines and mounting them on wheels, Cugnot by 1769 had built three steam vehicles which were tested under the direction of the French minister of war. Designed to draw field guns, the last of these vehicles to be tried was a three-wheeled tractor with a big boiler hung out in front and an engine with two cylinders over the front wheel. Steering was difficult because of the overbalance of weight on the front wheel. Cugnot's steam carriage carried four persons at a speed of two and one-quarter miles an hour but steam pressure was insufficient to drive the vehicle longer than fifteen minutes. When the tractor ran into a wall, the trials were ended.

The first really successful, self-propelled vehicle was built and run in 1784 by William Murdock, who had worked for Watt. It was driven by a one-cylinder steam engine, and is now in the British Museum. An American, Oliver Evans, built the first high-pressure non-condensing engine in this country in 1785—three years after Watt patented his double-acting engine in England. Evans' engine was so compact and light that it encouraged several Englishmen to make four-wheeled steam coaches and prepared the way for the railroad locomotive and the light steam carriage which became tremendously popular in the United States a hundred years later. Evans applied his steam engines to many purposes in the operation of mills and boats. He built a scow inland and ran it down to the river's edge on rollers under its own steam power. That was the first American automobile.

The first regular steam carriage operated in the United States was built in 1825 by Thomas Blanchard at Springfield, Massachusetts, but when he received little encouragement, he turned his attention to steamboats. In 1858, John Reed built a traction engine in New York and after driving it through the streets shipped it to Nebraska City. It broke down later on a test trip.

Meanwhile, other inventors were busy both in America and England. By 1833, twenty steam coaches were traveling in and around London. One of the first and most outstanding of these was a six-wheeled coach developed and patented in 1827 by Sir Goldsworthy Gurney. It was a clumsy but in-

genious affair and operated successfully. Draft for the boilers was supplied by a fan driven by a separate engine. In 1836, however, the steam automobile received a death-blow in England when the British Parliament passed the "Road Locomotive Act" which imposed such a high tax and contained such vicious features that all enterprise in developing the automobile was practically abandoned by the English until years later.

In the middle of the last century—1850—a Dr. Kier in Philadelphia made a discovery which was destined to be of tremendous importance later in developing the modern automobile. He found that when petroleum is heated the lighter parts are driven off and that the vapor can be cooled again into a light, refined oil. In this way he obtained kerosene which he burned in lamps. Gasoline, the lightest vapor, was allowed to escape because it was explosive. It was not until twenty-five years later that a way was found to use this powerful gas in engines. A few years after Kier's discovery—two years before the Civil War—a well was drilled in Titusville, Pa., from which flowed 1,000 gallons of petroleum a day. With the sinking of other wells, the great oil industry in this country began.

Discovery of these new liquid fuels stimulated many inventors, who mainly devoted their attention to using kerosene for heating water into steam. Amedee Bollee of Le Mans, France, patented a light kerosene-burning steam carriage and showed it at the exposition at Vienna, Austria. In 1875 he ran one through Paris at nineteen miles an hour. Leon Serpollet, who later became one of the greatest steam car manufacturers in Europe, came out with a three-wheel carriage twelve years after Bollee. One of the first Americans to turn to the steam car was S. H. Roper, a mechanic from Roxbury, Massachusetts, who was building steam bicycles and tricycles at the beginning of the Civil War and who continued at it until his death in 1894. It was he who introduced the light car in this country, or at least, his ideas led to the era of the light car.

Other Americans were active, too. Among them were George E. Whitney, R. E. Olds, and A. L. Riker. After patenting his invention in 1895, Whitney sold his rights to the Stanley Brothers and to John Brisben Walker, who founded

the Mobile company. The Stanleys sold many cars each year until they sold out to Amsi L. Barber, a match manufacturer, who then founded in 1899 the Locomobile Company of America. Barber immediately started aggressive advertising and was the first man in the industry to practice cheap production and low selling price. Barber sold more than 1,000 cars the second year he was in business. That was a new record for the industry at that time.

There is some dispute as to who it was that actually developed the first gasoline automobile, although the first four-cycle, compression gasoline engine was invented by Dr. N. A. Otto of Cologne, Germany. The first explosion gas engine was developed in 1799 by a French mechanic named LeBon. The piston was like a cannon ball and the cylinder similar to the barrel of a gun. He exploded street-lighting gas in the cylinder behind the piston. The force drove the piston toward the open end of the cylinder and it was fastened so that it was not completely driven out, and a new charge admitted. This same principle is used in all automobile engines to-day. LeBon used an electric spark to ignite the gas in his engine and this was followed in 1860 by another Frenchman, J. J. Lenoir. Lenoir built a one and one-half horsepower gas engine of the LeBon type and put it in a road vehicle.

It was in 1876 that Dr. Otto invented an engine in which the gas was compressed before it was exploded. He turned to gasoline after using street gas for a time. A fly-wheel was added to give the engine momentum to carry on the four cycles. No effort was made in the Otto Engine Works to turn out engines for anything but stationary work. But it was here that a man worked as a mechanic who was later and by some called the father of the modern automobile. He was Gottlieb Daimler of Württemberg, who had received an engineering education in the best schools and had some practical experience in some of the most famous machine shops of Germany and England. After leaving the Otto Works he opened a shop of his own at the age of 50 and began experiments to improve light gasoline engines for automobiles.

It was in this shop that Daimler built the Mercedes automo-

bile, which became world renowned, won many speed races and brought sensationally high prices. Daimler later produced the aspirating carburetor, in which the suction of the engine draws a current of air through the carburetor, and with it a fine jet of gasoline. Daimler was the first to adopt the V-type engine.

Another German, Carl Benz, meanwhile was active and turned out his first gasoline car in 1884, and patented it with belt drive in 1886. This was the first patent granted in Germany for this type of car and included many modern features such as water-jacketed cylinders and electric ignition. The first foreign car imported into the United States was a Benz and this was displayed at the World's Fair in Chicago in 1893.

The Austrians are disputing the claim of Daimler and Benz for the honor of inventing the first gasoline automobile. They assert it belongs to their own countryman, Siegfried Marcus who, according to these claims, constructed the first known petrol automobile in 1864. According to these claims, Marcus completed in 1865 his first model that actually ran and often thereafter took his friends for rides to the suburban parade grounds called the Schmelz. Marcus is said to have replaced his first rather primitive model in 1875 with his model number two which incorporated many advantages of the modern car, though none of its graces. This vehicle enabled the inventor and his friends to make excursions as far as Klosterneuberg, a distance of fifteen miles from Vienna. The Austrians recently honored his memory by erecting a statue to him.

Levassor of France became the leader of that country's activities in advancing the automobile. He became widely known as manufacturer of the famous line of Panhard-Levassor cars. They were the first to patent and construct cars with frames made separately from the body and secured to the axles by elliptical springs. Levassor also was the first to place the engine at the front, under a hood, and the radiator in front of the engine where it would get the full cooling effect of the air created as the car moved forward. Panhard and Levassor used differential gears in a cross shaft with two driving chains from the ends of this shaft to sprockets on the rear wheels.

They engaged in the first automobile trial run in July, 1894, from Paris to Rouen, a distance of eighty miles, which they won against others.

Meanwhile, Americans were coming into the field more aggressively. Many of these early inventors within the last two or three decades of the nineteenth century were far-seeing men who possessed real mechanical and engineering skill and visualized a great business for the mechanically successful automobile. They were inspired and prepared, too, by the bicycle craze which had spread throughout this country and which was reaching a peak by 1896, when there were 4,000,000 riders in the United States. Although the bicycle goes back to 1800, "wheels" received their greatest impetus and spread rapidly after Colonel Albert A. Pope patented the first safety bicycle and began manufacturing it in Hartford, Conn., in 1886. These early bicycles were very heavy, weighing in excess of 100 pounds and prices ranged from $150 to $200. Pope and other manufacturers turned to wooden rims, thin drawn-steel tubing, ball bearings, crank-shaft brackets, and other improvements to reduce the weight of these machines and by turning them out on a large scale were able to reduce prices to about $50.

With more than two hundred and fifty bicycle companies in the United States representing an investment of over $60,000,000, and with demands to produce them faster and in larger numbers, the bicycle industry prepared Americans for "mass" production which later was to be one of the most spectacular features of the automotive industry in the United States. Thus, special machinery was invented to turn out parts of the same kind in large numbers while there were companies which specialized in the manufacture of parts such as spokes, rims, tires, handle-bars and saddles. And this explains, too, why many of the early steam-cars, such as those made by the Stanleys and Walker of Locomobile, were light and contained many bicycle features in the use of steel tubing for frames, ball bearings, wire wheels, and pneumatic tires.

Of course, the rubber or pneumatic tire, made possible by the discovery of a process for vulcanizing rubber which an

American, Charles Goodyear, developed, had a very direct and vital bearing on the growth of the bicycle and automobile, later. Without the pneumatic tire, the automobile might still be the heavy vehicle which annoyed the English countryside years before. Many of the early builders of cars had used ordinary wagon or buggy wheels with steel rims.

Although the Europeans were aggressively developing the gasoline engine, America was "just around the corner" in these experiments. One of the first Americans to design and begin building a gasoline carriage was George B. Selden of Rochester, New York, who applied for a patent in the United States in 1879 or seven years before Benz and Daimler patented their ideas in Germany. Selden was a patent attorney and had received a thorough scientific training. Selden made up his mind that a better power for light carriages than steam could be developed and began experiments in his home which led to the building of his first gasoline engine in 1877. He then made drawings of a carriage to be driven by a three-cylinder engine mounted crosswise on the front axle.

If Selden had not been extremely persistent and skillful, his patent might have been lost on the shelves of the patent office. For years he vainly strived to interest capital in a venture to build his "horseless carriage" but met with many rebuffs. He finally obtained his patent in 1895 covering the principle of using an explosion engine in a road vehicle, but lost an opportunity to dominate or monopolize the industry because of the lack of backing or financial support.

There were many other men who later prospered in the automobile business, many of whom were operating under licenses to use the Selden patent. Selden brought infringement suits against Alexander Winton, Henry Ford, and others in 1902 and 1903. He formed the Association of Licensed Automobile Manufacturers about that time, which Winton and others joined. But Ford fought the case. While the courts decided that Selden's patent was good and the first one of its kind, they also were of the opinion that other manufacturers were using the Otto engines and that Selden had confined himself to the use of another type. It was revealed during this suit that

Selden received only $200,000 in royalties out of the $2,500,000 taken in by the Association.

During the early part of the last decade of the nineteenth century, there was an increasing number of Americans striving to develop a good gasoline-engined automobile. Perhaps for this reason there are several claims and some dispute as to who was first in making a successful gasoline automobile in America. Selden was the first to start his experiments and apply for a patent but the honor of actually building the first car and demonstrating it belongs to Charles E. Duryea. With his brother, J. Frank Duryea, he started experiments and in 1891 built a gasoline carriage. This did not satisfy them and they continued changing and improving until in 1894 they had completed their fifth buggy. This included such modern features as a four-cylinder engine with water jackets, electric ignition, bevel gear differential and pneumatic tires. It was this car which won the first American road race in the snow of Thanksgiving day of that year from Chicago to Waukegan for a cash prize offered by a Chicago newspaper. It held an average speed of ten miles per hour while most of the other contestants failed to finish. The next year the Duryea brothers built thirteen more gasoline motor carriages which were the first to be regularly manufactured for sale in this country.

There are some who say that Elwood Haynes of Kokomo, Indiana, brought out the first successful gasoline car in America in 1894. Haynes succeeded in obtaining the support of the Apperson brothers, who had a machine shop and permitted Haynes to experiment there. The first Haynes-Apperson was finished the same year that Duryea's third experimental carriage was successfully tested. Henry Ford, too, made his first successful automobile in the spring of that year.

About this time the Duryeas entered their machines in races being held in England and won the first contest in that country from London to Brighton. Spectators were startled to see the Duryea cars finish the race more than an hour ahead of the best French models which had won all races in France previously in competition with other European cars.

Haynes continued his experiments and improved his car, as

did others. He invented a successful carburetor and the first automobile muffler, introduced the use of aluminum into automobile engine construction, made the first 1,000-mile motor car journey, introduced nickel steel into motor car construction, invented and constructed a rotary valve motor and invented stellite and stainless steel. In 1910 he presented his first car to the Smithsonian Institute.

Meanwhile, the electric automobile, which was operated by power supplied by storage batteries and was first built by William Morrison of Des Moines, Iowa, in the summer of 1891, was rapidly becoming popular. About a year later, another electric vehicle known as a "brake" was developed by Fiske Warren of Boston. This was built to carry eight passengers at a speed of sixteen miles an hour for fifty miles on one battery charge. In 1893 C. E. Woods of Chicago and A. L. Riker of Brooklyn started making electric automobiles and a few years later the Waverly Company, Indianapolis bicycle manufacturers, and the Bakers in Cleveland started their careers in the electric vehicle industry. The Bakers, who made the first light two-passenger electric runabout, Pope, Riker, Waverly and Barrows electric vehicles were all exhibited at the electrical show in Madison Square Garden, New York, in 1898. A year later they were featured at the bicycle show. With more than one-third of the space taken up by electrical vehicles and the rest principally by steam-cars, the first real automobile show, however, was not held until 1900.

The Pope Manufacturing Company, which had turned from making bicycles to electric vehicles, was bought in 1899 by William C. Whitney, who also secured control of the Selden patent. Whitney, with several other capitalists, organized the leading electric vehicle manufacturers in important cities and operated them through the Electric Vehicle Company. Several important units in this first large combination started to make gasoline cars.

Alexander Winton in Cleveland manufactured twenty-one gasoline automobiles in 1898 and it is a matter of record that he sold his first car of a regular production schedule to Robert Allison, a mechanical engineer of Port Carbon, Pennsylvania,

for $1,000. It was a strange looking little machine, too, compared with the modern automobile. The body was built along buggy lines, had a curved dash like the dashboard of a sleigh and steered with a tiller. The engine was a single cylinder and the rig seated two. The tires were two and one-half-inch single tubes, fitted to thirty-six-inch wire wheels. Allison drove this car for three years until he turned it in on a new model.

R. E. Olds was conceded to be one of the first to bring out a cheap, American gasoline automobile. Although he had been experimenting with automobiles for fifteen years, Olds did not bring out his gasoline car until 1900 and sold it for $650. For those days it had speed, ran quietly and easily and was sold in large numbers. When Olds sold out, he started a new company in Lansing and by using his initials called it the Reo Motor Car Company. While head of the Olds company, he had trained several young men who later were destined to become leaders in the industry. One of these pupils was J. D. Maxwell, who later manufactured the Maxwell-Briscoe cars in the factory of the old Mobile Company at Tarrytown, and two others were Roy D. Chapin and Howard E. Coffin, who interested themselves in the E. R. Thomas Motor Car Company of Buffalo, brought it to Detroit, reorganized it as the Chalmers Motor Car Company and ultimately left the company to organize the Hudson Motor Car Company, in which they are still active.

Charles B. King is credited with building the first car in Detroit, the world's greatest automobile center. It was constructed in 1894 and carried a four-cylinder four-cycle engine, water jacketed. Two years later, he became an engine builder but when the King Company was founded in 1915 he was one of the organizers of the company.

Both in Europe and America the automobile was clearly the product of machinists and machine shops. Men with the mechanical twist, who loved the smell of machinery, were full of zeal to develop the first automobile. When the automobile did start to take hold and an increasing number of interests became engaged in its manufacture, many machine shops were turned into automobile factories which turned out the finished

product from the first machining process, while others specialized in the making of parts.

In 1893 H. H. Franklin founded the Franklin Company in Syracuse, New York, for the manufacture of die castings. It built its first model in 1898. In 1901 the company began the development of an automobile which was to be a radical departure from ideas prevailing at the time in that the motor was to be cooled by air driven by a powerful little fan instead of water jackets. The company increased its capital to $250,000 and completed its first car in 1902, in which year total output was thirteen vehicles. The company's first catalogue bears date of 1903. About this time, on July 25, 1903, John Wilkinson, designer of the Franklin car, won a five-mile race at Yonkers, New York, in his ten-horsepower Franklin, accomplishing it in 6 minutes, 54 3-5 seconds. This was a new speed record.

The first year of the new century—1900—was a fertile one for the beginning of many new companies in the manufacture of automobiles. Many have since fallen by the wayside in the economic struggle to survive and only slightly more than 20 per cent. of those who started in the business between 1900 and 1903 still exist. At the beginning of 1928, there were approximately fifty-five companies engaged in building automobiles. The F. B. Stearns Company was founded in Cleveland in 1900 and is still one of the few manufacturers of Knight motored cars which are produced under a patent.

Henry Ford has been and is to-day the most spectacular and dramatic figure in the automobile industry. After many vicissitudes and setbacks in his early days, Mr. Ford, in practically fifteen years, rose from poverty to such wealth as to count him preëminently among the world's richest. He has perhaps produced as many cars as the rest of the industry combined, and his success has been due to a combination of unusual qualities. With a definite leaning towards mechanics, he became an ardent believer in a business policy of low prices, large sales, and small profits. It was he who first went into big scale production.

Henry Ford's father, an Irish immigrant who came to this

country in 1847, wanted his son to become a farmer like himself but Henry felt differently about it. Young Ford worked for several years in Detroit as a machinist and steam engineer until, yielding to his father's inducements, he accepted some timber land, set up a saw mill, sold the lumber and fitted up an experimental shop with the money he obtained. His funds soon gave out and he went back to Detroit to earn his living as chief engineer of the Detroit Edison Illuminating Company, where he remained for seven years. He worked after hours at home experimenting with ideas for a gasoline automobile which he finished in 1893, shortly after the appearance of Duryea's motor buggy. Driven by a two-cylinder, water-cooled engine, this little car actually ran from twenty-five to thirty miles per hour.

In 1898—five years later—Ford organized the Detroit Automobile Company to build a better car he had developed. This company was not a success, however, and the shop was finally sold in 1901 to Leland and Faulkener, builders of fine machinery, who began making Cadillac automobiles.

His next venture was the organization of the Ford Motor Company with a capital stock of $100,000, of which Ford himself owned 25 per cent. The first Ford car was made by this company in 1903. As the company grew, Ford bought more stock to obtain control and interested other men in his company by giving them stock. Among these were James Couzens and Horace and John Dodge, who later organized the Dodge Brothers Motor Car Company. These men, who helped build up the Ford business, shared generously in its profits and later sold out to Ford. Each received millions of dollars for his stock.

How successful Ford was in selling his cars at very low prices is indicated by the growth of his plants which at their peak produced nearly 10,000 cars a day and employed 50,000 men. His profits ran into hundreds of millions.

Just five years after Ford started his last successful venture, another embryo giant in the automotive industry was born on September 16, 1908, by the incorporation of the General Motors Company of New Jersey. William Durant, who had

been engaged in buggy-making for many years, organized the company and held stock control. Although this company was formally dissolved August 1, 1917, to give complete stock control to the General Motors Corporation (of Delaware), it existed primarily as an operating company owning the plants, properties and other assets of its manufacturing units known as divisions. It was at this time that Durant sold his control to new interests. The General Motors Corporation also is a holding company owning part or all of the capital stock of other companies connected with its activities.

In addition to a host of manufacturing companies which make parts and carry on research activities for General Motors cars, the corporation controls these important divisions engaged in the manufacture of automobiles: Buick Motor Company of Flint, Mich.; Cadillac Motor Car Company of Detroit; Chevrolet Motors; Olds Motor Works of Lansing, and the Oakland Motor Car Company of Pontiac, Mich. The corporation in 1926 built a new plant to manufacture the Pontiac, which is a low-priced six-cylindered car. Another recent feature is the LaSalle, companion car to the Cadillac. The corporation controls the Fisher Body Corporation, which is the largest builder of automobile bodies on earth.

In the twenty years it has existed, General Motors has become the outstanding industrial corporation of the world. Its earnings have passed those of United States Steel and in value of output, according to 1926 and 1927 figures, it is the leading automobile manufacturer. Its unit production in 1926 was 85 per cent. of Ford's, but it passed Ford in 1927 as the latter closed his plants for months pending changes in models.

The rise of the Willys-Overland Company closely paralleled the period of General Motors. The author of this article had been engaged in the bicycle business when it was thriving most, but like others in this industry was fascinated by the possibilities of the automobile. In the panicky days of 1907 the writer was acting as dealer in Elmira, New York, for the Overland Company of Indianapolis, which was the company's first home, and which was first organized in 1903. Although that was his only connection with the company at that time, he felt that

the company had a bright future if properly managed as it was turning out an excellent and very salable product for the period.

The company, however, was rapidly plunging into financial failure and after staving off creditors and meeting payrolls with loans of friends whom he had interested, the writer early in 1908 reorganized the company and became its president. In 1909 the Overland Company built and sold 4,000 cars, doing a gross business of more than $5,000,000 at a net profit of over $1,000,000 and had $600,000 cash in the bank.

It was this spectacular increase in business that made the need for expansion of the Overland plants at some strategical point apparent. That is why the company in 1909 bought the Toledo, Ohio, plants of the Pope Toledo Company, which had quit the business. These were gigantic plants for those days and there were many who believed that the Overland Company was overbold in this move. A new assembly building was immediately erected and the Overland Company moved from Indianapolis to its new home in Toledo before spring of the following year.

Within eight years after the Overland Company had moved to Toledo, the sales organization had penetrated to every corner of the globe and the company swept to the front rank of the industry, which position it has held since. It now has the largest iron foundry in the world in connection with its Pontiac plants and builds all its own bodies in Toledo. It has a production capacity of 1,500 cars per day and employs between 15,000 and 20,000 workers.

It was in 1914, the year the World War started, that an event happened which was destined to play an important part in the automobile industry. Charles Y. Knight, an American, had invented a new type of motor using sleeves in place of the poppet valves of gasoline engines. He had been turned down by every important American automobile manufacturer, but chanced to meet the writer on a steamer in the Mediterranean. After hearing Knight's story, both returned to England, where a Knight-motored car was put through a series of severe tests.

The performance of the Knight motor was so impressive that the writer returned to America ready to build a car using a Knight sleeve valve motor. The Overland Company acquired the Knight patents to insure its dominance in the Knight engine field.

Other companies have come to the front and achieved enviable reputations in the industry but their names and histories are too numerous to mention in the space allotted. Studebaker turned from years of high-grade buggy and wagon making to the automobile. Packard was an early pioneer in the industry. Walter P. Chrysler in 1924 took over the Maxwell Company, which was in receivership, called it the Chrysler Motor Car Corporation and achieved a sensational success in an industry that has had more sensations than any other.

Development of commercial trucks followed in the wake of the passenger automobile. Motor buses were next. The truck was an almost indispensable part of the army's equipment in the World War along with motorized field guns. Trucks are being used as an adjunct to railroad and interurban service. The companies manufacturing them have prospered.

The automobile industry was the precursor of big scale advertising. No industry has used advertising in the volume bought by the automobile builders. If the automobile made advertising, certainly advertising made the automobile. Advertising made the American public automobile conscious. It fostered motoring. The advertising man had the "vision." He believed in the automobile. He said it constantly with white space.

"You can leave it anywhere with the assurance that it will not fret," declared the ad-writer, waxing enthusiastic over a Pope Waverly. A little previous to this the St. Louis Motor Carriage Company was tempting the prospective purchaser with the slogan "Rigs That Run." Even the accessory manufacturers played an important rôle in advertising the automobile. Remember the goggles and masks and capes and coats of years ago? The motorist was panoplied like a knight in armor. The manufacturers described these articles fervidly and graph-

ically in their advertising. To-day the automobile industry is spending many millions every year for advertising to sell its output.

The tremendous "mass" production of the industry to-day has been made possible by American mechanical genius. When the big factories began to make cars at a rate of many thousands a year, they adopted what is called "progressive assembling." Moving chainways or conveyors were installed which carried the cars to different groups of machinists. Stock rooms for the different parts or "units" around the assembling rooms were arranged and tracks and overhead carriers built to bring the units to the gangs of workmen. This method of progressive assembling has enabled America to make the lowest-priced, good automobile in the world. How efficient the industry has been is indicated by the fact that the 1928 price of automobiles has been reduced to 70 per cent. of the 1913 cost, whereas in the same period other manufactured products have increased to 167 per cent. of the 1913 cost.

The most phenomenal extent to which the industry has grown is shown clearly by the figures. In 1899—five years after the first American gasoline cars were successfully operated—there were 3,700 motor vehicles manufactured in the United States. They had a wholesale value of $4,750,000. In 1926—just twenty-seven years later—the industry produced 4,428,286 cars which had a wholesale value of $3,163,756,676. In other words, the retail price paid for American automobiles in one year was substantially in excess of four billions of dollars. Out of every family dollar, eleven to twelve cents is spent for motor cars. There are more than 22,000,000 motor vehicles in the United States, of which 2,764,220 are trucks and buses. This is a per capita distribution of one automobile for every six persons. It compares with one automobile for every 196 persons in Germany, where the first gasoline engine was built, and with one car for every 44 persons in France and one for every 74 in the United Kingdom. The state of California has one automobile for every 3.11 persons. This is the highest distribution in the United States.

In 1926, there was a total of $2,089,498,325 of capital in-

vested in the industry which directly employed 3,365,281 persons and indirectly 3,743,781, or a total of more than 7,000,000 persons affected. In point of volume and turnover of business the automobile industry easily outranks every other. In 1925 its sales, which totalled a wholesale value of $3,371,855,805, compared with $3,050,286,291 for the next greatest industry, meats and slaughtering, and with the total output of the nation's steel and rolling mills, which was valued at $2,946,068,231.

Insurance companies have expanded with the development of the automobile. Insurance premiums paid during 1926 for insuring the American automobile amounted to $428,088,202. Losses paid were $206,500,359. How the railroads have profited is disclosed by the fact that in 1926, when last complete figures were available, the industry loaded 3,280,000 freight cars with its products. The automobile has greatly aided the better-roads movement. Many thousands of new paved roads have been completed until America leads the world for the best roads.

The industry constantly is improving its products. Research laboratories are working to find better ways and new devices. Competition is keen. What will the motor car of to-morrow be? Will the automobile of ten or twenty-five years from now present the contrast that we see to-day between our modern models and those of twenty years ago? Perhaps it will.

Leaders in the automobile industry feel very definitely that the automobile has exercised a tremendous broadening influence on the minds of the American people. It has made them more tolerant. It has made neighbors more friendly. It has bred a newer understanding and sympathy. It has driven out provincialism as nothing else. The automobile has put Main Street on wheels to see the world. And this new gospel—this real fraternalism and good will towards man of the new millennium created by the automobile—is spreading to all peoples of all nations. It is humanizing the earth.

The automobile within a quarter century has brought about one of the greatest social and economic revolutions in the history of the world. The facts and figures prove it.

XXVII

MOTION PICTURES

By Will H. Hays

President, Motion Picture Producers and Distributors of America

ONE stands on a high mountain and sees long lines of men, women, and children moving slowly forward. They come from everywhere. They are rosy-cheeked girls from the farms, and their paler-faced sisters from the cities whose feet ache from long hours of standing behind bargain counters. There are plow boys, and sons of millionaires, and boys with the sallow cheeks of the tenements. There are old women with hands reddened and coarsened by work, and with eyes grown listless with long waiting. There are old men who hobble on crooked sticks, and children with the flash of the sun's gold in their hair and the happy laughter of innocence in their voices. There are the schoolboy, and the savant, and the man of no learning at all. There are men and women of every race and of every tongue, moving slowly forward, seeking something, seeking, searching, yearning—asking for a place to dream. All about them is the roar of the cities, the confused, jangling noises of life that is hurried, rushed, propelled forward at a breathless speed. Every minute of every hour of every day they come—millions of them. And over and above them, and in front of them, attracting them on, offering that which they desire, are billions of flickering shadows—the motion picture. Who shall estimate its importance? Who shall attempt to say what it means to the world?

The motion picture is the epitome of civilization and the quintessence of what we mean by "America."

Those are bold, maybe challenging, words; but I believe that

the motion picture's own story, its history and its proper achievements and anticipations are warrant enough.

Civilization may be said to be made up of four vital components: industry, science, art and religion. The motion picture will, upon examination, be found significantly to derive from and partake of the functions of all these.

Let us set it down immediately: the motion picture is a great social necessity, an integral part of human life in the whole civilized world. The thoughtful man can have no patience with those who would casually pigeonhole "the movies" with the ephemeral and passing whims that flutter through the current of amusements. We have had the motion picture now these three decades, developing and exploring its destiny through the ordeals of experience and demonstrating increasingly its fundamental values of service.

It is painfully true that not many, certainly not enough, people know the motion picture institution. A great many persons know the fame of screen personalities, a great many have marveled at the swift prosperity of the industry as evidenced in some spectacular careers, a vast public patronizes the screen for its products, but exceedingly few indeed, and some of them decidedly prejudiced, have given thought and research and study to the motion picture for itself in its broader aspects. That is natural enough. In parallel, most of us want to experience and enjoy health, but we are not on the whole vastly interested in physiology. But if we are to realize what the motion picture is and endeavor to think about it intelligently, we must give some heed to its inner facts. No superficial judgment of the motion picture has ever proved correct. Excellent reasons can be found for even its most bizarre manifestations, if one can see the screen with a broad angle, broad enough to take in all the facts.

Civilization follows the tools. The motion picture is the newest, and maybe the best, tool or instrument of the art of expression—and expression is the all of art. By art, man lives the fullness of life. Art is his triumph and release from all limitations of time and place and every manner of awkward fact. Art gives him many lives by vicarious living.

No one can fairly draw the lines that bound art, science, industry and religion from each other. Our civilization is a blending of them all. The motion picture is at once their product and servant.

You can turn to the writings of the scholars and the exhibits of the museums and trace there the entire genealogy of the art and industry of the motion picture as a tool. You will find interesting evidence that the roots of the motion picture run back into the unrecorded beginnings of human consciousness.

It is a fascinating progression that has brought us the motion picture as the newest and best way of telling things, the most direct route alike to the emotions and the intelligence. It began with pantomime, with by-paths into the spoken word, and evolved into drawing, pictographs and alphabets and written language, with other by-paths into sculpture and painting, and with paralleling evolutions of dance and song and ritual and pageantry and lastly drama. Expression ramified into apparently divergent arts as tools developed. All this development was merely toward better ways of telling things, more effective drives into the consciousness of the audience. The motion picture stands in direct line of descent and it is as definitely the offspring and descendant of the first primitive effort to re-create events for others by telling, in word and gesture, as the motor car is the descendant of the first ox-cart that creaked over the Aryan plain.

There will be little space indeed to tell any such a complex story here, but an examination into the history of the motion picture will amaze you with the array of savants and priests, and preachers and painters and scientists and magicians who have vitally figured in its evolution.

Expression means making the other man feel what you feel, see what you see. That is all that any of the arts are for, whether the expression is in marble or paint or stage drama or printer's ink. Let us put it down that the motion picture is the new, and possibly final, instrument of doing it and doing it more perfectly than it was ever done before.

We have arrived at the motion picture just about as early as it was possible to evolve it as a new tool from the older tools

developed ahead of it. It had to wait on mechanics, optics and chemistry. It came, as so many others of the great new necessities of the new life of our era came, in the wave of American invention, and like all other great inventions it has its debts to the centuries of European endeavor that have gone before.

And let me pause a moment to say here that there are special reasons perhaps why America should have given birth and prosperous nurture to the motion picture as a world art. America is in a very literal sense the world-state. All races, all creeds, all the manners of men that exist on the globe, are to be found here—working, sharing and developing side by side in a reasonable degree of understanding and friendship, more friendship among greater diversities of tribes and men than all the previous history of the world discloses. America's people do not speak of themselves primarily as Germans, Englishmen, Greeks or Frenchmen, as Catholics, Hebrews, Protestants, but as Americans. Ours is probably the least uniform of all nations, in the sense that France is French and Russia, Russian. But it is, at the same time, the greatest single unity among all nations, because America represents a harmony of diversified interests, all of which blend as do the pieces in an orchestra into one deep-toned symphony. Is it not possible that this very quality of harmonized diversities enabled America to express itself to the world by the creation and the development of the world's most universal method of expression—the motion picture? The nation required a method of universal expression. The motion picture is that method.

Thomas A. Edison's desire to gives eyes to his phonograph is primarily responsible for the motion picture camera as we know it to-day, according to Terry Ramsaye, historian of the motion picture.[1] Edison was at work, toward the close of the last century, on numerous inventions, but most of his interest was centered on the talking machine with which he had startled the entire world a short time before. William Kennedy Laurie Dickson, a young Englishman, who had traveled thousands of miles in order to associate himself with the Wizard of Menlo Park, was working for Edison and mysterious "goings on"

[1] A Million and One Nights.

were to be noticed in "Room Five" of the plant at West Orange.

Conscious scientific endeavor, first as a study of the nature of appearances of motion, and shortly of the synthesis of appearances of motion, began with the studies of Peter Mark Roget, the same whose name appears on the classic and authoritative Roget's "Thesaurus," first aid to word mongers, who was then secretary of the Royal Society in Great Britain, in 1824. After him came many experimenters, notably Joseph Antoine Ferdinand Plateau of Ghent, and Simon Ritter von Stampfer of Vienna, and later Lieutenant Baron Franz von Uchatius of Vienna and Emil Reynaud of France. While they studied motion, others, notably Louis Jacques Mande Daguerre and Sir John Herschel and others, pursued the chemistry which gave us photography.

Out of the labors started by Roget's studies came a machine which finally became the familiar toy called the Zoetrope, using hand-drawn pictures. Then, seemingly unrelated, came a method of recording motion photographically, evolved for Leland Stanford's race horse studies in California, by John D. Isaacs and operated by Eadweard Muybridge about 1880. Jean Louis Meissonier, famous French artist, applied the Isaacs-Muybridge pictures to the Uchatius projecting zoetrope and attained a crude limited sort of motion picture dependent on glass plates. It was only a tantalizing beginning.

Edison abandoned all precedents when he set to work in 1887, and early in 1888 we find the first effort toward the modern motion picture being made in the Edison studios recording the antics of Fred Ott, a mechanic, as the first actor, on a cylinder like that of an old Edison phonograph.

Years later, Ott told of that first performance before a motion picture camera. Repeated by Terry Ramsaye, it is:

"I had a white cloth wound around me and then a little belt to tie it in around the waist so as not to make it too baggy. I looked like a balloon. After I was ready, I made a monkey of myself and the camera was turned."

Mr. Ramsaye speaks of the first picture as "The Follies of

1888." "It was a slapstick comedy staged in a solemn laboratory," he adds with a chuckle.

But the Edison cylinder picture machine, built in simulation of the phonograph, was no adequate solution of the problem. Edison decided he wanted to feed the photo-material into the camera, and the subsequent pictures into a viewing machine, on a belt, like cartridges into a machine gun. He was looking for a flexible material to carry the pictures.

Now up in Rochester, George Eastman, who had invented the kodak, had a similar problem for what he called "roller photography." Edison was trying strips of collodion varnish when he heard that Eastman had arrived at a perfected material—for the kodak. Edison sent Dickson to Rochester for a sample.

That first order for film for the motion picture is still in Eastman's files at Rochester. With it went a postal money order for $2.50 in payment for a strip one inch wide and about fifty feet long. That test strip worked.

Imagine the thrill of that occasion. George Eastman's product had met and fitted Thomas Edison's product. *The motion picture had come into being.* And out of their union was to come the new and great motion picture which has since flowered into the world's greatest single source of amusement.

Edison moved on rapidly now in his studio, which, because of its resemblance in color to a police patrol wagon, was known as *The Black Maria.* He was still thinking in terms of eyes for the phonograph. But the moving picture was developing of its own accord. Annie Oakley; Sandow, the strong man; Buffalo Bill; dancers in Hoyt's "Milk White Flag," which was a Broadway success in those days; Ruth St. Denis were being induced to lend their talents to the moving picture, being recorded in single rolls of film fifty feet long for use in peep show machines which were now to appear as a forerunner of the moving picture. The first of the peep shows was opened at 1155 Broadway, New York City, on April 14, 1894.

As the motion picture began to develop into something like regular form and use, the makers of pictures began to consider

ways and means of getting popular pictures—a formula on which they are still constantly engaged. They recognized very early that plenty of action was needed and as prize fighting offered action and at the same time had a popular appeal, they turned to the prize fights of the day for filming purposes. James J. Corbett, heavyweight champion of the world, appeared before the camera. He became the first motion picture actor under contract. Later "Gentleman Jim" came back to the moving pictures but many gallons of water had flowed under the bridge between his first and second entrances into motion pictures.

Carmencita, a dancer of current popularity, and Annabelle Moore, who was a reigning favorite in the music halls of New York in the last years of the nineteenth century, also found their way into the new world of make-believe that was to be found in the peep shows of the country. An industry began to show signs of existence.

The public, expressing itself as usual through business, demanded a screen machine, a device which would liberate the motion picture from the peep show. Mr. Edison was not enthusiastic about this, although he had done some research and might readily have solved the problems of projection at once. He had been experimentally projecting since 1889.

Meanwhile a secret race to the screen was taking place. Probably the first to project, outside the Edison laboratories, was the late Major Woodville Latham, a hero of the Confederacy, from Virginia, who opened a flickering show at about 140 Broadway in May of 1895. Meanwhile in France, Louis and Auguste Lumière of Lyons, and Robert W. Paul of London achieved the screen, and in Washington, Thomas Armat brought forth a projector commercially shown in Atlanta in September, 1895. All of these machines were based on Edison's peep show Kinetoscope and used his films primarily.

Communication was slow then. When the showmen of New York began to demand a screen machine, the Edison agents, Raff & Gammon of New York, investigated Armat's invention, named it the Vitascope, and made a deal at West Orange to have it manufactured and offered as an Edison device—be-

cause the market looked to Edison, who was indeed the father of the motion picture.

The first showing was announced for April 20, 1896. The Vitascope was to be the last act on the variety, or vaudeville, program at Koster & Bial's Music Hall at Broadway and Thirty-fourth Street, New York. Delays, however, were to postpone the opening until the evening of April 23rd. The latter date is, therefore, recorded as the real birthday of the motion picture as a form of public entertainment.

It is a fine evening and the house is packed. Silk hats and evening clothes are plentiful. Some of the bloods of the town are here. Thomas Armat is at the projection machine. Thomas Edison sits quietly in a box, acclaimed by the crowd as he was to be acclaimed thirty years later when he modestly visited the opening of the great Paramount Theatre, ten blocks north of Koster & Bial's, but now, as on that later occasion, he is silent.

At last the pictures are thrown upon a twenty-foot screen which has been set in a gilded frame. There is the finale of Hoyt's "Milk White Flag," a dash of a prize fight, Annabelle Moore—the dancer—waves rolling in on Manhattan Beach. Marvelous! gasps the audience. Bravo! shout the gallery boys. As the waves roll in, the first-night audience—at least those in the front rows—jump from their seats and move back through the aisles to avoid being deluged, thus paying involuntary tribute to the reality of motion pictures. Sheepishly they return to their seats to applaud.

Praise! Words of congratulations! Excitement! Newspaper comment! Everybody is speaking of the Vitascope.

The moving picture had arrived. It was now a form of public amusement. Empty stores, holes in the wall, were soon to become alive with moving pictures. A good working machine was put on the market. The public was interested and intrigued. Traveling Vitascope showings aroused the country to eager interest in the new invention. Men, women, and children flocked in to see pictures that moved. It was thrilling, exciting—something new under the sun. Farmers left their plows, farm wives their chores, to see Edison's new wonder.

An interest was aroused that was to spread to the smallest hamlet, encircle the globe, enlist more people than any other instrument of entertainment the world ever knew.

And with the increased interest came a demand for more films. From far and wide came the call. People would gladly pay to see moving pictures, but they soon tired of seeing the same pictures over and over again. Novelty in pictures was needed. Thus from the first began the ceaseless struggle for variety of pictures—a struggle which explains why to-day there are 800 feature pictures annually.

The first picture makers had been able to induce some of the Broadway stars and some of the athletic heroes of the country, notably the prize fighters, to appear before the camera. In exchange for their services the stars got splendid advertisement. To-day it is with some justification said that stars demand and receive salaries commensurate with their services to the amusement-loving world.

About this time in the film's history, New York was being treated with what the citizens of that day regarded as a racy comedy called "The Widow Jones," in which Miss May Irwin and John C. Rice exchanged a kiss of almost modern prolongation. The moving picture producers of the day saw the advantages of the kiss on the screen and Miss Irwin and Mr. Rice agreed to reproduce it for the camera. It became an instant success under the rather obvious title of "The May Irwin-John C. Rice Kiss." It was forty feet long and it brought down on the heads of the infant industry several resounding raps. In spite of its popular appeal, a great many people disapproved of osculation to the extent of forty feet and to this day no one has ever definitely determined how many feet long a kiss may be and still remain a proper salutation.

Soon now vaudeville turned eager eyes upon the Vitascope and B. F. Keith houses began to announce it as an added attraction. Newspapers differed in their estimates of its possibilities, but shortly after the Vitascope's first appearance in Boston, *The Boston Herald* took occasion to predict a future. "May not small towns see city shows by the Vita-

scope?" *The Herald* asked. "May not actresses, who realize how fleeting youth is, preserve themselves in their prime? Indeed to what uses may not the Vitascope be put?" To which *The Boston Traveler* added, "Who knows how the new invention and those that are to follow may revolutionize the amusement world . . . Who knows that each country will not have its stage 'foundries,' so to speak, for each of the various forms of dramatic and musical art? Here finely drilled companies could give performances to be perpetuated by the Vitascope and the phonograph or their successors. Duplicates of the records could be sent by flying machines broadcast over the world and London's new play or latest sensational dance could be enjoyed in every quarter of the globe within a few days of the initial presentation."

Did they speak with prophetic tongues?

Busy days followed the introduction of the Vitascope. Bitter days, too. Patent wars were pending and all along the line new activities were to be noticed. The Vitascope had begun to have importance. Men were beginning to see money ahead. It was an open game, as Terry Ramsaye says, and anybody might become important over night. Every man who came in contact with the screen might call it his own. Some heartbreaks, perhaps many injustices, were to be endured before the industry became conscious of itself, of its importance, of its responsibilities, and opportunities. But these internal wrangles need not all be told here. They provide a thrilling chapter for the industry, but after all, all industries pass through such periods of unrest and instability. In a great war men die, they are maimed, blinded, diseased. Mothers are bereft of sons, wives of husbands, children of fathers. And yet in the golden sun of victory, these things, as lamentable as they are, must be judged in accordance with the great purpose, the ultimate end. In transoceanic flying we see brave young men—and fine young women too—sink to their deaths in the stormy waters. We are grieved; and yet for the future safety of travel, for the greater comfort of those who follow, we persist. These things have to be. It is the story of life itself. And so in the motion picture we find in those last days of the nineteenth century

strife and warfare, and not always the most desirable and admirable of methods. But these things we accept now—and with the shaking of a head, pass on, because that past is no more.

We pass on to—the beginning of the motion picture's consciousness of itself as an art. The filming of "The Passion Play" is the first notable move. Now follow such meager attempts at story telling as the filming of "The Life of an American Fireman" by Edwin S. Porter, then an Edison cameraman—a subject, by the way, which was utilized for the screen again in the year 1927, under the more fitting title of "The Fire Brigade." But seven and a half years were to pass from the night the first Vitascope was displayed at Koster & Bial's before a real motion picture with a real plot was to be produced.

"The Great Train Robbery," in which Mr. Porter built upon his technique in "The Life of an American Fireman," is generally regarded as the screen's first effort to tell a story in pictures. It was made by the Edison studios in 1903. Edison was fathering the evolution of the art from the seed of his peep show pictures.

"The Great Train Robbery" was a world-wide sensation. It gave rise to a great development in making pictures with stories. Showmen took to the road with it in black tents and made converts to the motion picture entertainment all over the world. It was followed by "The Great Bank Robbery," by "Raffles—The Amateur Cracksman," and by "Trapped by Bloodhounds, or a Lynching at Cripple Creek."

"The Great Train Robbery" also, by chance, gave the screen world its first star—Max Aronson, known presently as G. M. Anderson and later as Broncho Billy. From his day on, the star has been in the ascendant. The motion picture public demands its favorites and whatever can be said for or against the system, the public, as final arbiter, decides the issue.

On April 2, 1902, the first motion picture theater announced its entrance into the world. The Electric Theatre, 262 South Main Street, Los Angeles, told the citizens of that city, which later was to become the motion picture capital of the world,

that for the price of ten cents it would be glad to provide an hour's amusement in "a vaudeville of moving pictures" including "Capture of the Biddle Brothers" and "New York in a Blizzard." Business was so good on the opening night that matinées started the next day. In less than twenty-five years, there were to be more than 20,000 motion picture theaters in this country.

"The Electric" was the project of Thomas L. Tally of Los Angeles, the showman who many and many a year later was to figure again in screen history as one of the founders of First National Exhibitor's Circuit, now the world famous First National Pictures, Inc.

There were other tentative beginnings of a screen theater. So far, the career of the motion picture had been as a component of the bills of the variety theaters which were becoming more elegantly "vaudeville." One of the earlier theaters was opened in 1903 in Newcastle, Pa., by the Warner Brothers, due subsequently to figure conspicuously in the motion picture story.

Meanwhile the peep show motion picture continued to flourish in the penny arcades, of the sort that linger still in the congested regions of the greater cities. These arcades, trivial as they seemed, were to prove mighty agencies of the future, drawing to the picture a personnel that was one day to dominate the industry. Adolph Zukor, Marcus Loew, and William Fox are among the names of those who made this inconspicuous entry into the world of the films. Mr. Zukor, now president of Paramount Famous-Lasky Corporation, carries on to-day. Mr. Loew, whose untimely death in the summer of 1927 deprived the industry of one of its most cherished leaders, was the head of Loew's Incorporated, which included Metro Goldwyn Mayer, makers of "The Big Parade," "Ben Hur" and other notable pictures. William Fox is president of Fox Film Corporation, producer of many screen masterpieces.

While these men were serving their novitiate as purveyors of entertainment to the public in the movie slot machine peep shows, a mighty transition was impending.

Thanksgiving week in 1905, Harry Davis, then a real estate operator in Pittsburgh, decided to put a movie projector, a piano and some film into a vacant storeroom, along with ninety-nine seats, and see what he could do as a showman, with a five-cent admission. The show was "The Great Train Robbery." The experiment was a world-shaking success. The admissions poured through as fast as the one-reel show could be ground out. The East caught fire with the idea and five-cent motion picture theaters swept the country. Every week saw hundreds of new "nickelodeons" opened. By 1907 there were five thousand of them, all new customers for motion pictures, and making for the pictures a new public. Among the newcomers on this wave was Carl Laemmle, now president of Universal Pictures Corporation and a leader in the industry. He opened the White Front Theatre in Milwaukee Avenue in Chicago's West Side and there employed a bright messenger boy by the name of Sam Katz to play the piano. Mr. Katz is now the head of the far-flung Publix Theaters.

The coming of this new market put an extraordinary strain on the capacities of the producing machine of the motion picture industry of its day. The industry had been torn with internal wars and patent fights in the courts since 1896, the year the screen was born on Broadway.

But now studios had to be built and a stable organization set up. Hit-and-run methods would not serve.

In 1906 both the American Mutoscope and Biograph Company and the Edison interests, major opponents in the patent struggles, set up large studios to supplant their roof-top plants and backyard production methods.

In 1907, D. W. Griffith, a Kentuckian, a bit of an author and a good deal of an actor, ventured about seeking to sell some "suggestions" for motion pictures. They were really scenarios, but the word had not been invented yet, at least not for motion pictures. Presently he was employed by the Biograph Company and walked through that old brownstone door at 11 East Fourteenth Street in New York which was to be the golden gate to fame also for Mack Sennett, who was to evolve a whole separate art of production in motion picture

comedy, just as Griffith slightly before him set about laying down the foundation of the real dramatic art of screen narration. This was in 1908.

The motion picture, warring, needed peace. Biograph, in the artistic ascendancy due to Griffith, was about to go to the wall in the commercial and patent war. Then a practical peace for business' sake came in the truce that took form as the Motion Picture Patents Company, formed December 18, 1908, which pooled the patents and licensed every picture maker in America. In his analysis of this complex and trying period, Terry Ramsaye credits this labor largely to George Kleine, then the largest distributor of motion pictures in the world, and to Jeremiah J. Kennedy, a consulting engineer and business expert from "downtown New York," who became the chieftain of the organization. Discipline came into the industry for a time and it prospered as never before.

Only a few months later, in 1909, a certain little girl, legally one Gladys Smith, an actress in stock and with one Belasco engagement to her credit, went looking for "summer work" at the Biograph studio. She told the clerk at the inquiry desk that she was "Mary Pickford," her newly-acquired stage name.

Not long ago, a theater in New York put on a special revival of one of Mary Pickford's first pictures—a picture called "The New York Hat." It was crude and quite funny to the sophisticated audience. How they laughed! Back in 1909, it was a startling success. A little unknown girl in California had written it. Her name was Anita Loos. The story was that of a poor girl who wanted an Easter bonnet, a desire shared by countless of her sisters. A kindly preacher, knowing of her longing and of the hard life she led, sent the hat to her. The gossips in the village—Mae Marsh was one of them—complained. They did not understand and Mary's father said he would force the minister to marry her. That was what the minister wished to do all along as it turned out. The fashionable 1927 audience chuckled, and by their chuckling, they praised the progress that has been made.

It was the kind of picture Mary Pickford was to make

famous—the Cinderella story. "Little Mary," as she was known, became a national sensation. To-day Miss Pickford, one of the very few survivors of that pristine period of the screen, continues a vital and important personality of the screen, and to a degree that few outside of the industry know, one of its highly capable executives.

Following Mary Pickford's appearance, a long list of notables came—John Bunny, one of the first of the comedians; Bobby Harron; Mabel Normand; Henry Walthall; James Kirkwood. At first the actors from the spoken stage did not like the idea of appearing in moving pictures. They considered pictures degrading and vulgar. But the movies were attracting many actors from the stage and they were developing stars of their own. Mae Marsh, Norma Talmadge were being heard from. The names of J. Warren Kerrigan and of Maurice Costello were becoming known. Mack Sennett was getting ready to produce his famous comedies, the first of which appeared in 1912. While Sennett continues to produce comedies, other great names are associated with comedies too, in a list of which are those of Al and Charles H. Christie, who have achieved distinction in this important field.

About this time, Adolph Zukor got the idea of "famous players in famous plays." He secured the American rights to "Queen Elizabeth," in which Sarah Bernhardt played, and from then on the influx of stars was equal to the demand.

Sketching rapidly these eventful years—the names of Lillian and Dorothy Gish begin to appear. Wallace Reid, Clara Kimball Young, Francis X. Bushman, Beverly Bayne, Blanche Sweet are rising stars of the day. The motion picture had now advanced far since that showing at Koster & Bial's. It was time for a new sensation and the new sensation came in 1913 when George Kleine imported "Quo Vadis," which ran for twenty-two weeks on Broadway. The motion picture had arrived definitely as major entertainment. The whole world was interested. And only two years were to elapse until D. W. Griffith's "The Birth of a Nation" opened for a long run which was unparalleled until recently. This was March 3, 1915. The picture was shown at the Liberty Theater at $2.00

top price and with its appearance, it may be said that the screen had caught up with its older brother, the stage. Before long, Broadway was to be filled with motion picture theaters.

Meanwhile Jesse Lasky, who had already won fame in the world of vaudeville as a producer and executive of first rank, and Cecil B. De Mille, author of many plays and librettos for the stage, had rented a barn in Hollywood, California, and gone to work making motion pictures. The day of making pictures in New York was nearing its sundown. The great West with its salubrious climate, its sunshine, water, mountains, deserts, and plains, was beckoning to the movie. To-day we find production centered in California. The explanation is a simple one.

California had everything the motion picture director needed. It was made, apparently, for his uses. And so we have the unusual conditions of an industry, the production of which is centered in California and the distribution and financing of which are centered in New York, three thousand miles away. This has both advantages and disadvantages. Not only are the natural advantages of each place utilized but the viewpoint of East and West can be better analyzed and turned to advantage.

"Came the day," too, of the serial in 1913-14. "What Happened to Mary?" was revealed in countless reels. "The Adventures of Kathlyn" were duly recorded. "Dolly of the Dailies" became a national favorite. We suffered with "The Perils of Pauline" and we puzzled our brows to fathom the "Million Dollar Mystery." Pearl White, Marguerite Snow, Kathlyn Williams, James Cruze were followed every week by an interested public. And so it has been through all the industry's history until to-day when men, like Fred Thomson, preacher, Boy Scout leader, world famous athlete; Milton Sills, college professor, and others bring their lasting qualities to the screen.

The news reels, too, had come as a definite contribution to the screen. For a long time, as far back as the inauguration of President William McKinley in 1897, in fact, events of historical importance were recorded on motion picture film, but

it was not until the inauguration of President Woodrow Wilson that the news reel became a daily enterprise like the newspaper. To-day we find half a dozen great news reel agencies at work with cameramen in every part of the earth constantly focusing their lenses on every important happening in every land. They witness the pageantries and the tragedies of nations, show the customs and pursuits of all people, holding up a mirror, as it were, to every phase of human activity with vividness and accuracy.

But, stepping back to catch the thread and flow of development, the motion picture, with its world-wide distribution and its some eighteen or nineteen thousand nickelodeons in the United States and Canada, had not yet reached its full status. It was still a "nickelodeon" business.

Adolph Zukor with his long feature pictures of "famous players in famous plays" was still fighting an uphill battle, finding a home for the bigger product with the bigger idea. The old, established interests were holding to the nickelodeon idea and inertia was against the militant exponents of the new conception of the films and their function.

But on April 14, 1914, the Strand Theatre opened on Broadway in New York, a theater on a par with the pretentiousness of speaking stage houses, devoted exclusively to the motion picture. The opening picture was a nine-reel version of "The Spoilers" from Rex Beach's novel, produced by William Selig, a member of the Patents Company group who was leaning to the new bigger picture idea. The Strand was under the direction of Samuel Lionel Rothafel, the man whom the world was in years to come to know as "Roxy," one of the great showmen of the era. The Strand was the manifestation of a new idea which was to triumph. The Nickelodeon type theater lingers only here and there as a fossil survival like the occasional arcades, and the United States has approximately 20,250 screen theaters, and the world total of them is approximately 50,000.

It would be interesting to relate many movements of the busy, crowded years of this period. There is a fascinating flow of events in the manner in which W. W. Hodkinson and

Herman Wobber brought over to the new order the best that had been evolved from their experience as pioneers, especially as that service was applied to the distribution of the big new feature dramas of Adolph Zukor, Jesse Lasky, Hobart Bosworth and other producers of the big new feature dramas for Paramount distribution; how J. D. Williams, returning from experience in Australia, brought the infection of that great commonwealth's enthusiasm for the art; how Edwin S. Porter, maker of "The Great Train Robbery," went over to the feature idea with Famous Players, bearing with him the connecting link with the vast technical lore of the original Edison organization. I would like to tell you the amazing stories of the late William Rock of Vitagraph and his associates, all famous pioneers, and Sigmund Lubin and the rise of Stanley Mastbaum, and the exciting careers of Richard Rowland, Robert H. Cochrane, Nicholas and Joseph Schenck, Hal Roach and others. They have labored well and achieved much. And I would like, too, to tell you of Pathé Exchange's pioneering in the news reel and of First National Pictures, Inc., being formed by exhibitors and of Earle Hammons and the Educational Pictures, Inc., but these must be left to more leisurely written histories, as must be the entrance of Joseph P. Kennedy into the industry as president of F B O.

No story ever written for the screen is as dramatic as the story of the screen itself. Probably no other story is as long and complex, either.

I would like to speak of William S. Hart's rise as a great Western star and hero of boys of all lands, and of Tom Mix, of like fame; of the first efforts of Douglas Fairbanks, great artist, idol of boys, who has brought romance and the light of happiness within the reach of countless listless folk until they, too, share in the glamor of a new existence; of Hugo Riesenfeld and the development of music in the motion picture theater; of Jackie Coogan and the child actors; of the World War and the part the motion picture industry played in it. I would like to talk about Cecil B. De Mille's "The King of Kings"—the potentiality of which cannot be estimated—about De Mille himself, master craftsman, who has dared to go ahead, blazing

his own trail with mammoth productions of far-reaching consequence. But I must move on with the sweeping tide that brings the motion picture industry to an appreciation of its importance and of its opportunities.

Slowly, very slowly, the industry was growing into the consciousness of its own responsibility. The first years of the industry's development were of necessity chaotic. When keen men saw the commercial possibilities in it, they set out in feverish haste on the world-old quest for gold just as the Forty-niners did when word of the discovery came from Sutter's Hill in California. There was competition of the fiercest sort and for that matter there still is. There can be no monopoly of brains, the keystone of picture production. Competition is essential to progress. But the ethics of the competition have evolved. They have mounted constantly. The old careless, helter-skelter days are over. The chieftains of the motion picture now realize their responsibilities as custodians of not only one of the greatest industries in the world but of possibly the most potent instrument in the world for moral influence and education, and certainly one of the most universal mediums of artistic expression. They realize that never before has there existed any means by which the genius of a people could be so swiftly and dramatically presented to all other people and they govern themselves accordingly.

From a business standpoint, the motion picture industry has settled down and is operating along the sound, common sense lines which govern other American industries.

In the latter months of 1921, a growing consciousness of responsibility—recognition of the motion picture as something greater than a casual entertainment for the masses—began to reveal itself. The industry committed itself to an active policy of betterment. Leaders in the industry met and considered what steps to take. The result was an association of producers and distributors known as The Motion Picture Producers and Distributors of America, Inc.

The purposes of that association were chiefly "to foster the common interests of those engaged in the motion picture industry by establishing and maintaining the highest possible

moral and artistic standards of motion picture production, by developing the educational as well as the entertainment value and the general usefulness of the motion picture, and by reforming abuses relative to the industry."

These purposes were not to be simply a gentlemen's agreement. They were and are legal purposes of a legally organized body. Nine companies were represented at the organization of the Association. To-day twenty-seven companies are transcribing those ideals into performances. Those companies are: Bray Productions, Inc., The Caddo Co., Inc., Cecil B. De Mille Pictures Corporation, Chadwick Productions, Inc., Christie Film Company, Distinctive Pictures Corporation, Eastman Kodak Company, Educational Film Exchanges, Inc., F B O Pictures Corporation, First National Pictures, Inc., Fox Film Corporation, Inc., D. W. Griffith, Inc., The William S. Hart Co., Inspiration Pictures, Inc., Buster Keaton Productions, Inc., Kinogram Publishing Corporation, Metro-Goldwyn-Mayer Distributing Corporation, Paramount Famous-Lasky Corporation, Pathé Exchange, Inc., Principal Pictures Corporation, Hal Roach Studios, Inc., Joseph M. Schenck Productions, Inc., Talmadge Producing Corporation, United Artists Corporation, Universal Pictures Corporation, Vitagraph, Inc., Warner Brothers Pictures, Inc.

Associated with the Motion Picture Producers and Distributors of America is the Association of Motion Picture Producers of California, an organization designed to set into practice the ideals of responsibility and discharge of duty which actuate every branch of the organized and alert motion picture industry of to-day.

The industry had by now passed beyond the state of an entertainment force only. The screen was being used in many directions. It had become an aid to the educator, an ally of the scientist, the servant of clergymen, the friend of industries. How were these other agencies experimenting with the motion picture to get the best results from the screen? We found isolated instances of schools using pictures to help the teacher. We found a few scientific films about. Churches were ready to show religious pictures if they could get the ones they

wanted. Industries were beginning to understand that in addition to taking clothes, office equipment, machinery, automobiles, furniture, architecture to all parts of the world, they could perform certain useful things for industry at home. Motion pictures could teach employees better methods of operation, more skillful use of tools, better ways of living, safety methods. To all these legitimate demands the association turned its attention.

To recite the activities undertaken by the Motion Picture Producers and Distributors of America would almost require the time of their accomplishment. Obviously the first needs were to insure proper entertainment, to insure proper support for the worth-while pictures, and to lend assistance wherever it was needed in making the motion picture a greater servant of the world.

The first move was to make sure of the improvement in the wholesomeness of the entertainment. The motion picture theater is a community meeting house. There gather the families—fathers, mothers, and children. Motion picture success is based entirely upon ability to please the entire family and the success that has come to the industry, the real affection with which it is regarded by the millions, is genuine proof that the industry is succeeding in that effort.

Many persons have asked, "Why haven't we seen in the movies many of these recent books and plays that deal in themes and situations and topics which in previous years were discussed only in whispers"? The industry was determined that this type of book and play should not become the prevalent type of motion picture and to prevent this set up *The Formula,* which is this:

When any member company of the Motion Picture Producers and Distributors of America is offered the screen rights to a book or play which such member is sure is objectionable, it immediately informs the offices of the Association. If the judgment of the member company to the effect that the particular picturization is not advisable is confirmed after consultation, the author is advised, who may present to the Association his reasons why the story shall not be rejected; if it is

finally decided that the story is unsuitable then the author and all the member companies of the Association are notified.

After a story has been rejected the author may prepare a new story with the unsuitable material removed and with a new title and which title does not in any way suggest the old title, but using such dramatic incidents and interest as may be used and making certain the elimination of the unsuitable material. Then the author may submit such new story to the producing companies for picturization, as in the original instance, with the distinct understanding that it shall not be publicized or advertised in any way that will connect the new story with the old and that it shall not be presented in any way that will mislead theatergoers. If this is not done, then the company members, thus having their attention directed to the subject in question, have the opportunity of avoiding the mistake which the picturization of the novel or play would be.

The method, which is of course thoroughly legal and which has proved efficient, is not censorship in any sense of the word. No censorship could have brought about the results which have been attained. At the same time, the formula does not, by any possible interpretation, limit the production of vital or artistic pictures. Any method which did that would fail absolutely.

To insure support for the better type of pictures, the industry invited great national citizen organizations with millions of members interested in social service, education, religion, civics, to associate themselves with the organized industry in bringing about the results desired. The result was an organization which was unique—a Public Relations Committee. Among the sixty or more organizations represented on the committee were: National Society of the Sons of the American Revolution, National Education Assn., Federal Council of Churches of Christ in America, the International Committee of the Y.M.C.A., International Advertising Assn., Boy Scouts of America, Girl Scouts of America, The American Legion, American Federation of Labor, the National Community Center Assn., Camp Fire Girls, the American Sunday School Union, Chautauqua Institute, Daughters of the American Revolution, National Board of the Y.W.C.A., International

Federation of Catholic Alumnae, Russell Sage Foundation, Central Conference of American Rabbis, Associated Advertising Clubs of the World, International Catholic Welfare Conference, American Library Association, National Better Business Bureaus, et cetera.

The committee had its own officers, a paid secretary, and a smaller executive committee. For nearly three years the Committee was a functioning body. Under its inspiration great interest was aroused throughout the country in supporting the best pictures. Children's performances, known as The Saturday Morning Movies, developed and prospered. In its own office, the Motion Picture Producers and Distributors of America, in coöperation with the Public Relations Group, selected fifty-two complete programs of pictures of special interest to children. They were shown in many theaters throughout the country on Saturday mornings with a standard admission price of ten cents. When the programs became out of date, they were withdrawn but the movement continued. Now in many cities and towns special Saturday morning performances are given under the auspices of interested public groups who coöperate with the exhibitors, the pictures being selected from the current output of the studios.

In the spring of 1925, the Public Relations Committee, finding the work it had sponsored had become a permanent and actual part of the organized industry, asked that the committee be dissolved and a Department of Public Relations be established within the association. This was done. A small active committee remained and the advice and assistance of the larger group are still frequently used. The policy of the new department became immediately that of "The Open Door." This meant that every individual and every organization wherever located was cordially invited to bring constructive advice and suggestions to the industry. The response has been most gratifying and out of the coöperation have come splendid advancements in many lines.

In 1926, a Department of Industrial and Public Relations was opened in Hollywood in an effort to make sure that the working conditions of motion picture employees was kept the

best in the world and to develop still further the material used in the pictures and its treatment. A Studio Committee was organized, with a representative from every studio responsible for what goes into pictures. In advance of production expert advice is asked, from our State Department, from ambassadors from foreign countries, from church groups, education officials, civic leaders, and others whose opinions can be accepted as authentic.

One very concrete example of how the Open Door has helped is to be found in the establishment in Hollywood of an institution that is unique in business—a *free* casting bureau for extra people. The free casting bureau is operated, without cost to the employees, by the producing companies and there are registered eighteen thousand persons who are qualified to work as extras for one reason or another. Some are qualified because they have a wooden leg, others because they possess a fine growth of whiskers, some because they look like Italians or Germans or French, some because they own dress suits and can wear them in a distinguished manner, some because they own horses and can ride them.

These extras work from day to day. Each day's work is a job; 330,397 jobs were given in the year 1927—an average daily placement of 905 at an average wage of $8.59—all without cost to the employee. Their total of wages for the year was $2,838,136.30.

Of the average daily placement last year of 905, the number of men per day was 603, of women per day 269, and of children per day 33.

These figures are a blow to the beautiful girls who believe that Hollywood is longing for their art, and for mothers who think their children would add distinction to the movies. An average of only twelve children a day is employed through the casting bureau. These children when at work are under the care of teachers assigned by the Los Angeles Board of Education and paid by the producers. No children may act in the movies unless they are well up in their school work. School hours are maintained in the studio.

In its desire to increase the general usefulness of motion

pictures, the industry has coöperated with the church in the production of special religious pictures for showing in churches. After several years of intensive work with great educators, several companies are preparing teaching films for use in classrooms. This method of education will have an enormous effect for good upon the teaching methods of schools and colleges.

Pictures are being shown in ships to immigrants without cost. These films give them a concrete idea of the country to which they are coming and outline ways and means by which they can become good citizens and make a good living. Films have been sent to leper colonies in the Canal Zone and in the Philippines and to Eskimos in Alaska. Entertainment is furnished gratis to thousands of "shut-ins" in prisons, hospitals, orphanages and homes.

One of our companies in coöperation with the American College of Surgeons has just completed the first two of a series of pictures for use in preventive and remedial medicine. Pictures will be made of surgical operations, performed by the masters, in colors, in slow motion or magnified so that the details of the most intricate operations can be studied by surgeons in all parts of the world over and over again until they will be able to duplicate the work of the masters.

In the matter of commercial arbitration, the industry has shown its progressiveness. Disputes arising over contractual relations are necessarily inevitable in an industry of this sort where millions of contractual relations obtain for the showing of hundreds of thousands of pictures. Delays, one thing or another, may bring disagreements. The natural inclination is to rush into court. Pictures can't be tied up by courts. Time is too precious. And so the industry has adopted the arbitration system. In the key cities, there are arbitration boards, each composed of three exhibitors and three distributors.

In the last three years, the arbitration boards have disposed of 35,650 cases involving $7,374,661. Only ninety-two of these were litigated after submission to arbitration.

The motion picture, more than any other medium of ex-

pression in our modern life, has been hampered and beset by efforts of thoughtless persons to place legal restrictions on its output. They have not always realized that the integrity of motion pictures must be protected just as the integrity of our churches is protected and that the quality of pictures must be developed just as the quality of our schools is developed.

Motion pictures are not dead things to be regulated like commodities such as freight and food. They are evidences of human thought; and human thought, on which progress depends, cannot be tampered with safely. The tendency to censor, however, remains a mark of our times. The passion on the part of a small minority for regulating and directing other people to their will has become almost a national pastime. The industry's own not unnatural irresponsibilities during its formative years contributed to the agitation. More recently, the very real and personal interest in motion pictures as a means of entertainment and education has made the movies so much a part of everyday life that some people have appropriated to themselves the right of criticism. Changing conditions, the influx of new ideas and standards, the breaking down of conventions in other relations of life, reaction from the laxity incident to such a world upheaval as this generation knew, submission to governmental orders in stress of war, all added to the prevailing tendency.

So threatening indeed was the political invasion shortly after the termination of the World War, that thoughtful men and women in and out of the industry saw that continued aggression would ultimately mean that there could be no physical distribution of motion pictures in America. The industry, hampered by conflicting laws, would have been forced out of business.

Seven states, by the close of the war, passed laws providing for the censorship of motion pictures—Pennsylvania, Ohio, Florida, New York, Kansas, Maryland, and Virginia. Then, after 1921, there began a reaction against censorship based upon the proved ability of the industry to govern itself and the added knowledge by legislators that the people themselves did not want censorship. Two of the seven states—Kansas

and New York—have recently repealed that part of the law affecting news reels and educational subjects. In thirteen states which considered censorship laws in 1923, the measures were overwhelmingly defeated by public opinion.

The only time the people of a state have had the chance to express their opinion, they voted "no." That was in the State of Massachusetts where the censorship of motion pictures was put directly to the people in 1922. The citizens of that state defeated the proposed censorship 553,173 to 208,252—a majority of 344,921 against censorship.

Motion pictures remain the most typical of American productions. Standing well among the first ten industries in this country, the motion picture industry stands first probably in the percentage of the world's supply of a single commodity. These figures issued not long ago by the Department of Commerce at Washington are surprising:

	Per Cent.
Of the world's land, United States possesses......	6
Of the world's population, our people make up....	7
Of the world's wheat, we grow.................	27
Of the world's coal, we dig....................	40
Of the world's telephones, we use..............	63
Of the world's corn, we grow...................	75
Of the world's automobiles, we make more than..	80
OF THE WORLD'S MOTION PICTURES, WE PRODUCE MORE THAN..........................	85

Two hundred and fifty-five thousand persons are permanently employed in the industry in this country and more than $125,000,000 is spent annually in production. Last year, 823 feature pictures were produced and several times that number of short subjects, news reels and travelogues. It is estimated that approximately one hundred million Americans go to the movies weekly. Our pictures are shown in seventy countries with titles translated into thirty-seven tongues. Last year, we exported 235,585,000 feet of film and every day approximately twenty-five thousand miles of motion pictures are handled, examined, stored, and shipped by employees in the

exchanges of members of the Motion Picture Producers and Distributors of America.

Two new instruments have been added recently—the Vitaphone and the Movietone. Both synchronize sound with the pictures, and while each is founded upon a distinct and unlike principle, the achievement of both is the same. These two instruments hold unlimited opportunities. The day will come when the finest music in the world may be reproduced for the smallest village. Warner Brothers, in conjunction with Western Electric Company, is presenting Vitaphone in many theaters now. Fox Film Corporation is presenting the Movietone. The latter is being used with specially good effect in connection with news reels, events being recorded and retained not only in visual form but in sound as well.

The future of the industry one hesitates to predict. So great has been the advancement in the narrow scope of thirty-one years that to attempt to estimate the future appears puerile. One can see only expansion, development, progress. The motion picture will not only retain its present popularity but will of course add immeasurably to it. It will add also to the list of beneficial services which it already is performing. Producers are taking the best men available into the studios and they are teaching them methods of production which cannot help but result in a steady flow of finer and finer pictures. Universities and colleges throughout the country are teaching motion picture technology and appreciation. All of literature, all of modern writing, provides a wealth of story material. New mechanical developments are coming every day. Theaters are marvels of comfort and beauty. And the producers and custodians of the motion picture in every branch of the industry are aware of the responsibility upon their shoulders.

Thoughtful people are agreeing with our persistent contention that the motion picture is one of the greatest forces yet given to man to bring a happier understanding not only between men but also between nations. And herein lies what I confidently believe is one of the greatest future possibilities of the motion picture. The motion picture knows no

barriers of distance nor of speech. It is the one universal language. All men, wherever they may live, can find on the screen a story they can understand. If we can only have understanding, we shall not only be peaceful and kindly among ourselves, but we shall remain at peace with all nations. When we understand, we do not hate and when we do not hate, we do not make war.

To promote this international understanding by sympathetically telling the story of the nationals of every country to the nationals of all others is the determined purpose of our Association.

The great need of the future, of course, is manpower. The motion picture business is built largely upon personnel. Take away the directors, actors, writers and nothing is left but a highly organized production, distribution and exhibition machine with nothing to keep it running.

The greatest difficulty in progress has been in those phases of art in which it has been necessary to develop the talent completely. And there has been the most significant development. It is as if in twelve years from the time man first began to construct buildings, the Woolworth Building was erected; as if twelve years after the invention of the violin we had produced Kreisler, Kubelik and Mischa Elman.

In the late months have come forward so many fine directors, skilled writers and talented actors that the motion picture is producing at least once a week a story that compares favorably with the best in art, in the drama and in literature.

The only reason the eight hundred motion pictures produced within the year are not all of the quality of the two hundred outstanding ones is for the same reason that we do not have eight hundred great novels or eight hundred great plays in a twelvemonth. The necessary manpower does not exist.

It is merely a question of finding men and women who have the talent necessary to make always the very best. Motion picture producers are trying to employ only the directors and writers who have that ability. They are doing their utmost to develop them. Directing and scenario writing are two great professions that are a part of this and no other enterprise.

Applications by the thousands come from persons who want to write scenarios or direct pictures. In most cases they are persons who are not qualified to pass even the first test. The result will be a mass movement upward. Men and women will come to the industry already prepared in the fundamentals of the business they are to follow and inspired to give their time and their talents to this great new art.

Recognition of the motion picture as an art by the great universities marks the beginning of a new day in motion picture work. It paves the ways for the motion picture's Shakespeares.

I wish it were possible here to draw aside the curtains of the future and to peer at what is to come, for the future, I have no fear, will be great.

William Kennedy Laurie Dickson, Edison's early laboratory assistant, far back in 1896 forecast the future of the motion picture.

"It is the crown and flower of the nineteenth century magic," he said, "the crystallization of eons of groping enchantments. In its wholesome, sunny, and accessible laws are possibilities undreamt of by the occult love of the East: the conservative wisdom of Egypt, the jealous erudition of Babylon, the guarded mysteries of Delphic and Eleusinian shrines. It is the earnest of the coming age, when the great potentialities of life shall no longer be in the keeping of cloister and college, of money bag, but shall overflow to the nethermost portions of the earth at the command of the humblest heir of the divine intelligence."

I agree with Terry Ramsaye when he says, "Will Hays himself could say no more, to-day."

XXVIII

AVIATION

By Harry F. Guggenheim

President, Guggenheim Foundation for Promotion of Aeronautics

THE Gods of Greek and Roman mythology never had any trouble in flying to their destinations. Since the desire to fly was a common human longing, it was natural that the Gods, who possessed all the talents men wanted most, should be endowed by their worshipers with this ability to travel swiftly through the air. Hermes or Mercury, who carried the Gods' messages, did not have to worry about impassable forests and deserts or the barriers of mountain and river; otherwise, the Gods would have been several months late in most of their decisions upon human affairs.

By myth and legend the dream of flying persevered; and the Icarian Sea still bears the name of Icarus who fell into it when the wax, with which his wings were fastened, was melted by the sun. Perhaps this was the longest unfulfilled dream of man, because it was not until 1783 that man first arose in the air in a balloon, and not until 1903 that he first achieved true flight in a craft heavier than air.

For this reason a survey of a century of progress in aviation comprises most of the history of aviation. The science of aeronautics is a product of the last hundred years; the significant achievements, even the significant theories, are similarly recent. That is not to say that scientists and scholars were not concerned with the problem long before that time. In the fifteenth century Leonardo da Vinci, probably the most versatile master of art the world has known, designed a wing-flapping machine to be operated by man-power—the Smithsonian Institution has a model constructed according to his

ideas. A later Italian, Borelli, pointed out that no man would have sufficient strength to keep these wings moving so rapidly as to sustain flight; but da Vinci's manuscripts, discovered after three centuries, give a series of astute observations on the flight of birds, and provide notes and designs for flying apparatus and helicopters. His sketches and treatise on the parachute might well earn for him the title of the father of the parachute.

The most notable invention for air flight preceding the balloon was Francis Lana's air-boat of 1670 which was to be lifted into the air by means of the ascensive power of four large globes of very thin copper, from which the air had been wholly exhausted. Lana's calculations of a copper globe which would weigh less than the air it displaced called for a copper of such thinness that it would not have been able to withstand the external pressure of the air when the internal air was removed.

John Wilkins, the Bishop of Chester, in a treatise written at the end of the seventeenth century, summed up several ways by which "flying hath been or may be attempted: First, by spirits or angels; second, by the help of fowl; third, by wings fastened immediately to the body; fourth, by flying chariots." And upon an odd mixture of contributions of this kind, from dreamers, philosophers, inventors, and scientists, was constructed the foundation for the actual balloon flights of the eighteenth century.

It should be pointed out that there are two distinct classifications in aeronautics: lighter-than-air craft (aerostation), and heavier-than-air craft (aviation). The first began its development sooner than the other; starting with the balloon, it proceeded slowly into the dirigible. Progress with the dirigible has been hampered by the enormous overhead cost. The development of the airplane, heavier-than-air, has been therefore more rapid, although more recent.

THE DEVELOPMENT OF LIGHTER-THAN-AIR CRAFT

Two Frenchmen, Joseph and Etienne Mongolfier, were the first to send up balloons, and to them goes the glory of making

it possible for men to rise in the air. In 1783, the two brothers gave their first public demonstration with a spherical balloon of 110-feet circumference, made of paper and inflated with heated air. This balloon, without passengers, ascended about six thousand feet and caused a sensation throughout Europe. In September of the same year, with a much larger balloon, the Mongolfier brothers repeated the experiment with living animals as passengers—a sheep, a cock and a duck.

It was now man's turn to attempt the flight, and one can hardly conceive to-day the anxiety which attended man's first passage. A certain Pilatre de Rozier—later killed in an attempted flight across the Channel—volunteered to make the flight, but the King of France, Louis XVI, directed that two men under sentence of death should be sent up. Pilatre de Rozier was indignant, saying: "What, shall vile criminals have the first glory of rising in the air! No, no, that can never be." Louis XVI yielded, and de Rozier was the first man to make a balloon ascent. In the presence of Benjamin Franklin and others, he rose to a height of about seventy-five feet, which was the length of the rope holding the balloon captive.

The first American to come into prominence in the history of flying was Dr. Jeffries who accompanied the celebrated French aeronaut Blanchard on the first aerial crossing of the English Channel in 1785. The honor of making the first aerial voyage in the United States goes to the same aeronaut, Blanchard, who made a flight in 1793 from Philadelphia in the presence of George Washington.

The navigation on these flights was made at the wind's will, and not at the will of man. This was no more satisfactory than cruising in rudderless ships. Many ingenious, though futile, devices, such as sails, oars and paddle wheels, were employed to control the flight. It was not until 1852 that an appreciable measure of control in a light wind was accomplished in a balloon. This was made possible by a distinguished engineer, Henri Giffard, who designed and built a dirigible balloon elongated in form and powered by a small single-cylinder steam engine of three horsepower, capable of a speed of about six miles per hour. The airship evolved by

slow stages till 1898 when Santos Dumont equipped a small dirigible with a gasoline motor and startled the world with his spectacular flights.

The history of modern airship development is largely the history of its development in Germany. In 1908 the interest of the German people in airships expressed itself in a popular subscription of approximately $1,500,000 for airship development. This subscription forms the basis of the "Zeppelin Foundation for Promotion of Airship Navigation." The far-reaching Zeppelin organization of to-day is still endeavoring to carry out Count Zeppelin's ideas of a world-wide network of airship lines.

The first commercial airship operating company was the "German Airship Transportation Company" or "Delag" which was formed in 1910 by a number of public-spirited citizens in order to start an airship passenger and mail service within the borders of Germany. Several airships were built and operated between 1911 and 1914 with striking success, even though they were not large enough to cover long distances. Four- or six-hour flights at forty miles an hour were the maximum. Prior to the interruption caused by the war, the half-dozen airships of the "Delag" had made some sixteen hundred flights carrying thirty-five thousand passengers without a single casualty.

During the war, there were built in Germany some one hundred airships which were operated with varying degress of success. These airships were of only three or four basic types. After the Armistice the Allies forbade the operation of commercial airships in Germany, and the Germans sought to keep airship transportation alive in other countries. Efforts to form connections in the United States finally resulted in the construction in Germany of an airship for the United States Government. This—the "Los Angeles"—was of commercial type embodying the latest German practices. It is now being operated by the Navy Department for training and experimental purposes. At about the same time, an agreement between the Zeppelin Company and the Goodyear Tire and Rubber Company gave to the latter the American rights to

the knowledge and experience of the Zeppelin Company. This has been put into effect by bringing a group of the best German engineers to this country. Congress is considering the authorization, as part of the Navy's Five Year Aviation Program, of the construction of two airships of six million cubic feet capacity.

The commercial possibilities of airships have been indicated in three transoceanic crossings. The "Los Angeles" made a non-stop voyage from the heart of Germany to Lakehurst in 1924 covering the five thousand odd miles in eighty-one hours, or at an average speed of over sixty miles per hour. At the present moment, airships provide the only practicable means of long oversea flights, and the public is familiar with various projects for luxurious "liners" to cross the Atlantic equipped with stateroom, dining-rooms, dance floor, and all the usual social paraphernalia now connected with an ocean voyage.

THE DEVELOPMENT OF HEAVIER-THAN-AIR CRAFT

In the midst of this period of development of aeronautics, the modern science of aviation had its birth from the mind of Sir George Cayley. He pointed the way to the solution of flight in heavier-than-air craft in the following simple, but comprehensive formula: "To make the surface support a given weight by the application of power to the resistance of air."

The experimental and theoretical contributions to the science of aeronautics made by Cayley and others were utilized by two great English pioneers of flight in the middle of the nineteenth century, W. S. Henson and John Stringfellow. As early as 1840 Henson had been experimenting with model gliders and light steam engines for the production of what was known at the time as "Henson's Aerial Steam Carriage." Insofar as design of the plane was concerned, this strikingly resembled a twentieth century monoplane.

The public was not interested, and lack of funds compelled Henson to abandon his experiments. Stringfellow continued the work and between 1846 and 1848 constructed the first engine-driven model to raise itself in the air and fly a short

distance. The success of this model has been attributed to the use of theories promulgated by da Vinci and Borelli, which heretofore had never been put into practice.

For a time after this, experimentation was confined chiefly to the structure of the aircraft itself. The experimenters stopped worrying about an engine that would be sufficiently powerful and not too heavy, and were content for the nonce to practice with gliders and gliding flights. Cayley and Henson had used gliding models, but now full scale gliders, capable of carrying a man, were developed and flown. As early as 1867, Le Bris, a sea captain of Brittany, made a glider in imitation of a huge albatross. It is said that on one occasion he attached his glider by a rope to a horse-drawn cart, and after being launched in the air in the manner of a kite, rose to a height of about three hundred feet. But it was not until the end of the nineteenth century that soaring and gliding flight became a real art, through the efforts of the great German pioneer, Otto Lilienthal. He was followed by Pilcher in England, and Montgomery and Chanute in America. In those days, with no knowledge of the practical problems of flight, gliding was extremely hazardous. Of these four outstanding pioneers, three made the supreme sacrifice by giving their lives in the cause of aerial progress.

While these gliding experiments were taking place in America, England and Germany, a Frenchman, Clement Ader, was attempting power-driven flight without the preliminary stages of long training in gliding. It was probably due to this lack of training that his success was not complete. Ader constructed a machine of batlike form with a steam power plant of between twenty and thirty horsepower driving a four-bladed propeller. According to Ader, in 1890 and again in 1897 he actually rose from the ground and flew for a very short distance, but in both cases the plane was wrecked in landing.

The second of these trials was an official one, before two generals and a lieutenant of the French Army. The official report admitted that the machine made several hops above the ground, but did not consider the performance as one of actual flight. There has been much controversy over the supposed

flight of Ader, but to-day it is generally admitted that Ader did not actually fly, though his contribution to the art of flying was of great value.

The scene in the conquest of the air now shifts to America. Just before the triumph of the Wright brothers, two other Americans, Samuel Pierpont Langley and his aide, Charles Manly, made a gallant effort for victory. Langley, a scientist of note, set about to develop his airplane or, as he called it, his "aerodrome" by slow and thoroughly scientific stages. He began with the construction of a series of over thirty rubber-driven models. After achieving success with these, he constructed power-driven models with an automobile steering apparatus which made possible long and steady flights. These models were driven by specially designed steam engines and demonstrated the skill of their inventor. Finally President McKinley in 1898 encouraged Langley in his attempt to construct a man-carrying airplane capable of mechanical flight for use in warfare, and the War Department gave Langley an appropriation of $50,000 for this purpose.

The work was slow. The actual making of the plane had to wait upon the development of a light and sufficiently high-powered gasoline engine. By the summer of 1903 Langley had succeeded in completing an airplane driven by a gasoline engine which could carry a man who would direct and control the flight. On October 7th and again on December 8th two official trials were made on the Potomac near Washington, but the launching gear failed to start the airplane properly in the air and it was unable to rise. The official report of the U. S. Artillery Corps in part said: "These unfortunate accidents have prevented any test of the apparatus in these flights and the claim that an engine-driven, man-carrying aerodrome has been constructed lacks proof, which actual flight alone can give." A few years later, Langley died, a bitterly disappointed man.

Nine days after Langley's unsuccessful demonstration, on December 17, 1903, at Kitty Hawk, N. C., the Wright brothers made their first successful power-driven flight and realized for the first time man's age-old dream of moving at will through

the air. Recognition for their great achievement was long in coming. On December 26, 1903, nine days after the flight, the *New York Times* mentioned the achievement in a short statement, to the effect that a flight had been made in an airplane which sometime in the future might prove of use to the Signal Corps of the U. S. Army. At that time so little vision was had of the vast possibilities of the airplane and so little importance attached to the enterprise that the name of the Wright brothers was not even mentioned in the newspaper report.

The success of the Wright brothers was due to long and diligent study of the science of aeronautics as it existed up to their time, to practice in gliding flight over a period of many years, and to their mechanical genius. The famous flight of Orville and Wilbur Wright at Kitty Hawk was only the beginning for them of many years of pioneer flying during which public support was most grudgingly given. It was not until July, 1909, that the Wright Flyer successfully passed the final acceptance test prescribed by the United States Government.

In the meanwhile, the Wright brothers had been to Europe and had introduced the Wright plane in European countries. Between the years of 1903 and 1909 many distinguished pioneers were carrying on important developments in Europe, especially in France. Among them was Louis Bleriot, whose daring and successful crossing of the Channel on July 25, 1909, fired the public imagination of that day.

From 1909 to 1914 the airplane had a very limited field as a means of transportation or as a military weapon and was used almost exclusively by pilots for stunt flying at county fairs and exhibitions. The aviators were heroes who risksd their lives at every flight, and many of the best known aviators rode on the crest of fame for a very short time before they were killed, due to the imperfections of the machine then in existence.

It has been said that civil aviation dates its true birth in America in 1913. From the year 1903, when the Wright brothers made their first flight, until 1913, just five airplanes

were sold in America to private individuals for personal use. But in 1913 some forty-four planes were sold. A majority of these were the flying boats invented by the famous pioneer Glenn Curtiss, and in them more than a score of amateurs flew over two hundred thousand passenger miles.

During the early war period, progress in American aviation was slow. On the battlefields of Europe, however, the airplane was proving of such strategical value that its wider use was recommended.

The Germans had entered the war with a small, but well-organized airplane industry for war purposes. They had over six hundred airplanes, mainly two-seaters. These were of standard design, and this greatly facilitated replacements. The French air force at the beginning of the war had about an equal number of machines, but these were not standardized and were of many different types. The British contributed in 1914 eighty-two planes, mainly of French design. An English historian commenting on these early contributions to the Allied cause by the British says: "It is on record that the work of providing spare parts might have been rather complicated, but for the fact that there were none." The Belgians had about twenty airplanes suitable for active service in 1914. The Italian air fleet was also small, but as the war progressed, Italy's contribution of airplane engines was a particularly valuable asset to the Allies. The history of Russia's airplane development during the war period, while never of great importance, is principally marked by the capable design of one Russian engineer.

Immediately upon the entry of the United States into the World War in April, 1917, the Army and Navy Joint Technical Advisory Board, basing their estimate upon an army of one million men which the War Department expected to place in the field, recommended the immediate manufacture of three thousand airplanes. After conference with the English and French missions, however, it was decided to manufacture twenty thousand airplanes instead of three thousand. England at this time was losing about as many airplanes per month as she could manufacture. France needed planes badly, and so

did Italy and Belgium. The American industry realized the difficulties of its task in expanding the few existing factories to handle an enormous production of an unstandardized product.

There was a further complication in the fact that our military advisers could not agree upon a production program for service types. After orders were placed with the industry, they were frequently canceled or changed. Airplanes were often hardly delivered at the front before they were obsolete. An improved design found in a German plane shot down behind the Allied lines called for a new Allied plane embodying the German improvements and some advance over them.

In addition to the airplane building program, inventors faced the task of designing a standardized aircraft motor, which could be produced in quantities. The result was the Liberty motor, one of the great mechanical achievements of the war. In eighteen months of intensive war effort, American manufacturers produced and delivered nearly fifteen thousand complete airplanes and nearly twenty-four thousand aeronautical motors. This demonstration at that primitive stage of airplane development is an indication of airplane production possibilities in the United States. The war ended just at the time that large production was reached, but the effect of this production in helping to bring about the Armistice must not be overlooked.

With the termination of the war, the American airplane industry collapsed, like so many industries that were chiefly dependent upon war orders for existence. Not only did Government orders terminate, but also huge stocks of war material were thrown on the market which were sold for between 10 and 20 per cent. of the actual cost of production. Most of the manufacturers closed their doors. A few of the stronger companies—for the most part those which had not been brought into existence by the war-time emergency—struggled against adversity, anticipating the present day era of aeronautical development. At this time there was no Government policy for the development of even a small air force for the

normal needs of the Army and Navy, which would have provided an incentive for the industry.

Each year since 1919 basic legislation for civil and commercial aviation had been urged, and each year it failed. The principal reason was apathy, not opposition. In June, 1925, therefore, in collaboration with the American Engineering Council, the Secretary of Commerce, Herbert Hoover, appointed a joint Committee on Civil Aviation to review the aviation situation in its economic aspects.

The Committee, unlike any that preceded or followed it, confined itself to the commercial phases. This committee urged that Congress enact a civil aeronautics law providing for the establishment of a Bureau of Civil Aeronautics in the Department of Commerce, with power, among other duties, to regulate civil air navigation in the United States; to license pilots and inspect and register aircraft; to develop, or take over and maintain air routes and air navigation facilities.

At about this time public opinion was focused on aviation by the violent attack of General William Mitchell on the aircraft policies of the Army and Navy. General Mitchell had a splendid record of courage and leadership as an officer in the Air Corps of the American Expeditionary Force, and later served as Assistant Chief of the Army Air Service; but many believed that his criticism was an overstatement and that he attacked good along with bad. President Coolidge had been planning a personal investigation, and in the midst of the Mitchell controversy he appointed a committee headed by Dwight W. Morrow, now American Ambassador to Mexico, to investigate aviation affairs.

The work of the Morrow Board marks a turning point in the history of American aviation. The Board's recommendations were of so sound and practical nature that most of them were speedily put into effect, with the result that the progress of American aviation in the past two years merits the adjective "stupendous." One of the Board's most important recommendations was the appointment of assistant secretaries in the Departments of War, Navy, and Commerce who would be responsible for aeronautical affairs. F. Trubee Davison, Ed-

ward P. Warner, and William P. MacCracken, Jr., respectively, were appointed to these positions, and their work has justified the confidence placed in them by the industry.

While America was completely neglecting aviation in the period immediately following the war, there was much activity in Europe. This was due to a policy of direct Governmental subsidy in England, France, Germany, Holland and other European countries. Subsidy for infant industries is the traditional method of Governmental encouragement to industry in Europe—a tradition contrary to the policy of our Government. In the long run American aviation will surely be benefited by doing without a direct Government subsidy. Direct subsidy is a means of forced development, quite likely to defeat the very object sought, namely, the establishment of the industry on a sound economic basis.

In Europe the subsidy had a political and military motive, as well as an economic one. European commercial aviation has never been on a sound business basis. Nevertheless, there are in the Eastern Hemisphere more than forty-three thousand miles of developed air routes, over most of which organized passenger and freight carrying air lines are running on regular schedules. Many of the principal cities of Europe are connected by these routes. Europe and Africa are connected by an air line, and an extension of this line from Africa to South America is now under way. The British Government has developed an air line between Cairo, Egypt, and Karachi, India.

American aviation developed along entirely different lines and without subsidy. Although passenger-carrying was not inaugurated in the United States, this country established probably the most important single aeronautical development in the world, namely, the transcontinental air mail service. The first air mail route in the United States was opened May 15, 1918, between Washington and New York, in coöperation with the War Department. The service was transferred to the control of the Post Office Department in August; it was operated until 1921 when it was discontinued. The first link of the transcontinental route was opened in 1919, and the final link a little more than a year later.

For the fiscal year 1926 the total number of miles covered by the U. S. Air Mails was 2,256,000. These figures compare very favorably with the total mileage in the operation of all European services at that time. The passage of the Kelly Bill in February, 1925, which provided for Government contracts with private companies for the transportation of the air mail, was another great step forward. At the present time all the air mail routes in the United States are privately operated. On July 31, 1927, there were fifteen mail airways in operation or under contract, nine more advertised and three new mail routes. These twenty-four mail routes will serve 65,677,209 people in the various trading areas along these airways with seventy-five station stops. The postage rate on air mail is now ten cents a half ounce, regardless of distance carried.

There is another development that had its origin in America shortly after the war and is hardly existent in European countries—the employment of aircraft for a number of uses which have been classified under the name of "Aerial Service." This includes aerial photography and surveying, crop protection and pest destruction, forest patrol, coast guard and border service, fish spotting, taxi flying, and flying instruction. The origin of these services can be traced to the adventuresome spirit of American pilots of the World War who, returning to America, bought at their own price war-time equipment and eked out a living by following county fairs, taking up passengers and performing stunts for the amusement of the public. They were known as "Gypsy Fliers" and their activities called "Barnstorming." To these men an important part of the great growth of aeronautical development in the United States is due.

The latest information of the Department of Commerce indicates that over ninety manufacturers are now engaged in the construction of airplanes, that a plane cannot be purchased under ninety days delivery, and that about six thousand new planes will have been produced in the year 1927. The tremendous progress in airplane performance is indicated by the comparative statistics of speed.

When the first Wright biplane flew at Kitty Hawk, it carried one man, a couple of hours' fuel, and had a speed certainly

not exceeding thirty-five miles per hour. The history of the Schneider Cup Race shows the development since then. In 1913 the winner was France with an average speed of only 45.4 miles per hour; in 1920, Italy at 107.2 miles; in 1921, Italy at 114.4; in 1922, England at 146.1; in 1923, the United States at 177.4; in 1925, the United States again at 234.4; in 1926, Italy at 246.5; and last September, England at 282.5.

Mention should be made of the Wright Whirlwind motor which has admittedly been a factor in the advance of commercial aviation. This is the motor used by Lindbergh in his flight across the Atlantic and the motor used by Chamberlain and Acosta in the "Bellanca" when the new world's endurance record was established. This development began in 1920, and since that time seven successive models of air-cooled engines of this type have been devised, progressing finally into the "Whirlwind" of to-day, which has given consistently reliable performance.

Aeronautics is now a science. In all of the countries where aviation has made progress, there exist important centers of aeronautical research and experimentation. Progress in the development of aircraft to-day is not dependent upon cut and dried methods, but upon the highly trained specialist in aeronautical engineering. This is no implication that aviation no longer needs inventive genius—there is always need for genius; it merely indicates the scientific background which aeronautics has gradually achieved.

Probably the outstanding contribution to that science in recent years has come from Dr. Prandtl of the University of Goettingen, in Germany. The German universities took the lead in the introduction of aeronautical engineering courses, while to France goes the credit for the pioneer wind tunnel work in the famous Eiffel laboratory. In England the great National Physical Laboratories have been of valuable assistance to the cause of aviation, and the Royal Aeronautical Society of Great Britain, which was founded in 1866, holds a unique position in this work.

Although America has probably not contributed as much in the pure science of aeronautics as the other nations, neverthe-

less the laboratories of the National Advisory Committee for Aeronautics at Langley Field are perhaps unequaled anywhere in the world, and their contributions are increasing in value and volume. In addition, experimental work is constantly carried on by the Army, the Navy and the Bureau of Standards. In January, 1926, the Daniel Guggenheim Fund for the Promotion of Aeronautics was established with an endowment of $2,500,000. Its purpose is to assist in the extension of fundamental aeronautical science and to foster the development of commercial aircraft and aircraft equipment. The Fund has made grants to five universities for the establishment of aeronautical engineering centers. These universities—Massachusetts Institute of Technology, University of Michigan, New York University, California Institute of Technology, and Leland Stanford University, now have, or will have shortly, personnel, laboratories and equipment sufficient for the complete training of aeronautical engineers in both undergraduate and graduate work. In addition to its educational activities, the Fund has undertaken the furtherance of the safety of aviation, by organizing a Safe Aircraft Competition which is already international in its list of contestants.

Transportation of passengers under properly organized conditions has reached a state of safety comparable with other means of transportation. Proper conditions for safety in flying include the following:

1. Highly skilled and experienced pilots are essential. In the hands of a skilled expert the airplane is safe; in the hands of an amateur it is distinctly unsafe. With progress in design, this extreme dependence on the skill of the pilot will diminish.

2. Adequate equipment—airplane, engine, and instruments—is of primary importance. The best modern airplanes are of light, but reliable, structure. Modern engines have reached an extraordinarily high state of development as demonstrated by endurance flights of 50 to 60 hours. Multi-engined planes, designed so as to fly with one or more engines out of commission, offer an additional safeguard.

3. The ground organization should include a highly trained operating personnel for the care and maintenance of flying equipment, landing fields and airways.

4. The regular airways should be lighted for night flying and have at convenient distances emergency landing fields.

5. A meteorological service for aviation assures accurate knowledge of weather conditions. The development of this service not only for the reporting of actual weather conditions on the route, but also for the purpose of short time forecasting is still in its infancy in America. Along with this, a communication service from the ground to the plane is a final essential, reporting weather conditions and position when visibility is bad.

The summer of 1927 marked an epoch in the public realization of the possibilities of the airplane and their acceptance of it as a new and important means of transportation with which they themselves were about to be intimately concerned; and, strange to say, this public acceptance was not due to any great invention, not due to any revolutionary development, but was due to the almost superhuman effort of a gallant American aviator, Charles A. Lindbergh.

On the morning of May 20th, at 7.52 Charles A. Lindbergh, flying a specially designed Ryan monoplane, equipped with a Wright Whirlwind motor, alone in his plane with five sandwiches and a canteen of water for refreshment, set off on a non-stop flight for Paris. The whole civilized world was the audience that witnessed this performance on the great stage of the Atlantic Ocean. The opening act of this drama had been presented about eighteen months before, when the American Naval Officer, Commander Richard Evelyn Byrd, together with his pilot, Floyd Bennett, had courageously conquered the North Pole by air. Byrd had scarcely completed his flight when the airship "Norge," with an international crew of Amundsen, a Norwegian; Nobile, an Italian, and Ellsworth, an American, flew over the North Pole after having navigated their airship from Rome to the Arctic. This was a fine opening act, and the world audience applauded.

There followed a series of dramatic and tragic scenes. Captain Rene Fonck prepared for a non-stop flight from New York to Paris. After long preparation and many trials during which the public waited expectantly, Fonck crashed on his take-off with his great load, and his giant plane was consumed

by fire within a moment, and two of his crew killed. Preparations were made by others for the flight to Paris. Davis and Wooster, American airmen with splendid records, were killed in testing their plane under the huge loads that were necessary for such a flight. Commander Byrd had organized an expedition for the Paris flight; in the first test prior to the delivery of his plane, there was a crash and his pilot, Floyd Bennett, was seriously injured. Commander Byrd continued his preparations and they were nearly completed in this eventful month of May. Close to his hangar another expedition under the leadership of Chamberlain was making preparations for the New York-Paris flight.

The western side of the Atlantic was not the only side where preparations were under way. Persistent rumors were heard daily that a flight from East to West was imminent. The public was startled in May with the news that Nungesser and Coli had begun the perilous flight from France. Throngs of Americans waited at the Battery in New York to receive these gallant Frenchmen in their arms. They waited in vain. Reports of terrific storms in the North Atlantic were heard, and though the destiny of those gallant French pioneers, who risked their lives that aviation and humanity might progress, will probably never be known, it can be guessed.

This drama of aviation had deeply moved its international audience. In the midst of these tragic events Charles A. Lindbergh, unknown air-mail pilot, entered the lists. After months of careful preparation and after the expenditure all told of but an insignificant sum of money for such an undertaking (in all about $13,000), he started on May 10th from San Diego to New York with an intermediate stop at St. Louis. He arrived in New York unheralded, but he established a record for non-stop flights on his way. When it was reported that he was to fly to Paris alone, some thought it a joke, others thought he was a madman, and there was hardly one who did not think that his prank would end, if indeed he went on with it, with his body resting beside his French companion pioneers. But in the midst of these speculations and predictions, the morning of May 20th arrived and Lindbergh had set off for Paris.

The rest is history, and history much better known than histories are apt to be. Lindbergh completed the 3,610-mile flight in 33½ hours, an average of a little over one hundred miles an hour. By his skill and daring he not only aroused the interest of the public in aviation; he also secured the confidence of the public in aviation's future. The first book of aviation has now ended—the book of patient, hazardous endeavor by a small group of experimenters and of no practical interest to the public; the second book is now beginning—the book of the public utility of aviation, engaging the interest of every one. It is fitting that Lindbergh should have introduced this second volume in the record of aviation with the same sacrificial courage that characterizes page after page of the first.

There are others who followed Lindbergh, in the last half of 1927, with daring achievements in long-distance flight. Clarence D. Chamberlain, with Charles A. Levine as a passenger, flew the Bellanca monoplane "Columbia" from Roosevelt Field, Long Island, to Helfta, Germany, near Berlin, in 43 hours, covering 3,905 miles. Lieutenants Lester J. Maitland and Albert Hegenberger, of the United States Army, flew 2,400 miles from California to Honolulu. Commander Richard E. Byrd, undaunted by his first failure, flew from Roosevelt Field to France, landing at sea some 200 yards from shore near Ver-sur-Mer. Edward Schlee and William Brock in "The Pride of Detroit" left Grace Harbor, Newfoundland, in August on a round-the-world flight which, through weather conditions and because of public sentiment against the risk, was abandoned in Tokio, Japan, after a trip of 18 days covering a distance of 12,295 miles.

No appeal of science to man's reason could have accomplished in a period of years what Charles Lindbergh's appeal to heart and imagination accomplished between the dawn of May 20th and the nightfall of May 21st. The world was impressed with the significance of the airplane not only as a lessener of the distances between the habitations of men, but between the minds of men as well.

One by one the barriers between nations are falling.

XXIX

RADIO

By James G. Harbord
President, Radio Corporation of America

RADIO is in many respects peculiarly American, though the credit for its early conception must go to the Italian youth Guglielmo Marconi, who in the closing days of the last century conducted his epoch-making experiments on his father's estate near Bologna. Radio, however, is an art rich in experimental possibilities, teeming with research and engineering problems, and always a challenge to that uncanny ability certain men have for converting a mere idea into a practicality. Suiting the American taste for initiative, for investment in the future, for rapid progress and for doing things on a vast scale, the radio industry has been a truly American industrial and sociological achievement.

Although radio to-day is represented by several major branches of the art—radio broadcasting, transoceanic radio, marine radio, and the radio receiver industry—its origin may be traced back some thirty years to the practical experiments of Signor Marconi, with electro-magnetic waves. The action of such waves was known for many years prior to Marconi's experiments. In fact, a German professor, Heinrich Hertz, had discovered that the propagation of certain electromagnetic waves was due to a condenser discharge, thus unknowingly laying the broad foundation for space communication by wireless telegraphy. Other savants thereafter had performed laboratory experiments with these so-called Hertzian waves. Yet it remained for imaginative youth, as exemplified by Marconi, to conceive of practical communication without wires by means of these far-flung waves.

It was but natural that this new method of communication should seek a virgin field for its early efforts, since in its infancy it could ill afford to cope with the older and highly developed cables and telegraph lines. Hence wireless took to the sea, and soon became a practical if limited means of communicating to and from ships. It became the greatest boon to navigation since the invention of the magnetic compass by the Chinese many centuries before. Wireless, even in its then admittedly crude state, had found an indisputable niche in the practical world, quite beyond the borders of other systems of communication.

There passed several years during which the young inventor and his supporters struggled to improve marine wireless communication. The existing wireless facilities were looked upon as an interesting novelty, but lacking in real value to warrant the investment required for ship installations. The exchange of a handful of messages could hardly justify the widespread use of this scientific toy.

So might wireless progress have followed its fitful course, but for a turn of fate which provided that dramatic moment when the attention of the entire world was focused on the struggling art. In 1909 the steamship "Republic" met in collision the Italian ship "Florida," off Nantucket. The crash came in the middle of the night, and the first call for help, flashed from the ocean by a wireless operator, thrilled the startled world. This was the famous C.Q.D. signal sent out by Jack Binns, whose coolness and presence of mind saved the lives of 1,500 human beings on the sinking ship.

That disaster, coming during the struggling and discouraging days of wireless, served to crystallize, for the benefit of humanity at large, the inestimable value of radio on shipboard. Soon it became compulsory, by international law, for all seagoing vessels carrying fifty persons or more, to carry wireless facilities and competent operators. One by one passenger ships were equipped with wireless, followed by slow-moving freighters and wandering tramp steamers. Land stations, to maintain contact with the increasing number of floating wire-

less stations, grew in numbers until they freely dotted the various coasts of the civilized world.

Although the first commercial exploitation of wireless communication took place in Great Britain, whither Marconi repaired for financial support, the young art soon introduced itself to the United States, where its possibilities were appreciated from the start. After a time, American wireless companies came into existence, although for a long while the destinies of wireless on this soil rested largely in foreign hands.

In marine communication, as in other branches of wireless, or radio as it came to be called, the United States eventually secured the leadership and has maintained it ever since. Although not a maritime nation, we have nevertheless provided the most advanced type wireless equipment for our own ships and those of other nations. We have also established the most efficient land stations to be found the world over. The latest advances in radio have always been applied to marine radio, so that this phase of radio has more than kept up with other branches playing a more intimate part in the everyday lives of the people.

Vacuum tube transmission has brought in its wake a flexibility of operation unthought of in former days. The early spark transmitters emitted such broadly tuned waves that communication channels were seriously limited and with many ships trying to put through their messages at one time much interference existed.

Whereas there were some twelve spark stations in operation along our Atlantic Coast from Cape May to Bar Harbor in 1920, operating on only two wave lengths with a virtual bedlam of interference, the introduction of continuous wave transmission soon reduced this number to a few marine centrals, with multiplex facilities and sharply tuned waves for supplying a number of short and long wave channels. Interference was reduced to a negligible minimum, and vastly increased facilities were introduced with the concentrated equipment and personnel.

To-day the bulk of marine communication between ships and

our coasts is handled by a small group of highly efficient marine centrals. Shipping entering or leaving the port of New York is handled by the RCA Bush Terminal Station in New York Harbor. The Tuckerton Station in New Jersey handles the coastwise shipping, reaching down even to the Caribbean Sea. The Chatham Station on Cape Cod handles the transatlantic shipping far out to sea. In the Gulf of Mexico, radio traffic is handled by the Galveston Station. Great Lakes traffic is cleared through the RCA Chicago Station. On the Pacific Coast, the traffic is handled by stations at San Francisco and Los Angeles. These various stations are arranged for multiplex operation, so that a number of incoming and outgoing messages can be handled simultaneously.

Marine traffic to-day attains formidable proportions. The large passenger steamers alone will handle several thousand radiograms in the course of a single voyage. Most of this traffic is routine, but occasionally present-day radio, prosaic as it is becoming, once more encounters opportunities for demonstrating its heroic capabilities. The flashing of an SOS rarely fails to bring succor to the distressed ship; and marine radio has developed its corps of brave men ever found ready for an emergency when life becomes secondary to duty.

While American ingenuity and enterprise might well be content with providing such facilities for the seafarer, another step ahead is the radio direction finder or radio compass. This device, with its directional loop and special receiving set, serves to locate the source of intercepted radio signals. In this manner other ships can be located, as well as land stations. Bearings can be taken by means of known land points. Ships, unable to take their own bearings, may be located by means of direction finders on other ships or on land. To facilitate the taking of bearings, especially at night or during dense fog, special automatic radio transmitters or radio beacons, sending out identification signals corresponding with the flashes of light-houses, have been installed along our coasts and on foreign shores. Aside from the convenience and safety derived from the use of the radio direction finder, a vast amount of

time is saved to maritime commerce through this device which enables vessels to proceed with certainty and safety under all conditions.

During the development of marine radio communication, collateral radio progress has been made in the other major branches. Harking back once more to the formative period of radio or wireless communication, Marconi not only effected communication with ships at sea, but his experiments led him to attempt the span across the English Channel between England and France by wireless, in competition with submarine cables. From the thirty-odd miles of that rough waterway, Marconi soon turned his attention to the three thousand miles separating the Old World from the New. From battery-operated spark coils, he graduated to huge generators and powerful transformers, coupled to lofty antenna.

On a purely experimental scale, signals were flashed across the Atlantic as early as 1901. Using a kite-supported antenna at St. John's, Newfoundland, Marconi himself intercepted the three dots of the letter S employed as the test signal. By 1907, Marconi had succeeded in spanning the Atlantic, between Ireland and Nova Scotia, and in 1908 such a service was opened to the public. Other high power stations soon followed, bringing radio communication into the transoceanic field in competition with the submarine cable. Soon it became apparent that its commercial ambitions had grown far in advance of the technical achievements of the young art. The key to continuous, reliable and economical transoceanic service had not yet been found. Existing equipment could not generate sufficient power in suitable form to transmit radio messages regularly across the Atlantic.

The emergency of the World War found the United States with reliable transoceanic communication only to Great Britain, and with just a makeshift service to South America. To the rest of the world communication was beset by censorships, delays, relays and other obstructions. It was during those trying days that the American nation realized the value of American communication service to all parts of the world,

which would be free from interference in peace and in war alike.

Meanwhile, the United States took the lead in technical research and development, with the notable development of the Alexanderson high-frequency alternator and the improved radio receivers, which, for the first time, made possible continuous and economical radio communication over vast distances. The technical means of long-distance radio communication was now at hand. There still remained, however, the organization of capital and facilities and personnel to carry out the ideal of an American world-wide communication service to a complete realization.

It was in April of 1919 that the Radio Corporation of America was conceived, out of the necessity for centralizing American inventive and productive skill, at the urgent invitation of Government officials. The new organization, amply financed, immediately purchased the property of the British-controlled Marconi Company, secured rights under the important American radio patents, and forthwith placed in service a number of stations connecting across the Atlantic to Great Britain, France, Germany and Norway, as well as across the Pacific to Hawaii and Japan.

The progress of American world-wide communications stands without parallel in the annals of industry. In the few years since the close of the World War, there have been established direct, high power, reliable and economic radio circuits between New York City and Great Britain, France, Germany, Sweden, Norway, Holland, Poland, Italy, Argentina and Brazil, with additional South American circuits to follow. Transpacific radio circuits are now in operation between San Francisco and Hawaii, Japan, the Philippines, Java and China, with promise of early extension of the service to French Indo-China and other points in the Far East.

Fifty years were required by Great Britain in realizing its splendid world-wide cable system, with London as the hub. In less than a decade, the American world-wide system has reached a comparable state of completeness.

American inventive talent has found a most prolific and re-

munerative field in transoceanic radio, at first by working out the sound technical fundamentals of economical and reliable service, and later through numerous refinements leading to more efficient handling of an ever-increasing radiogram traffic.

Thus the former hand-operated telegraph key, which laboriously and slowly formed the dots and dashes of messages to be painstakingly copied by the distant operator across the ocean, has been displaced by the automatic transmitter whose typewriter keyboard is operated by the nimble-fingered operator. Endless lines of perforated tape flow from the perforator typewriter, passing through the automatic transmitter proper controlling the powerful transmitter many miles away. At the distant receiving station, the dots and dashes are led to an automatic recorder which writes them down in wavy lines on a paper tape that files past the operator seated at a standard typewriter, upon which they are transcribed into words on a radiogram blank. Despite the huge increase in operating speed, accuracy has been maintained at the highest standard, by automatic transmission and automatic reception, with a permanent record of the radiograms as transmitted and received.

Instead of individually operated and scattered transmitting and receiving stations, connected to centers of population by long telegraph lines with their added toll charges, as in the past, American ingenuity has made possible the operation of a group of transmitters and receivers placed at remote and advantageous points, from a central operating office in the very center of population.

To-day, from the New York traffic office, transmitters as far distant as Marion, on the south shore of Massachusetts, Rocky Point on Long Island, and Tuckerton in New Jersey, are controlled by operators who never see the actual transmitting apparatus. Likewise, receivers as far distant as Riverhead on Long Island and even Belfast on the coast of distant Maine, are employed to intercept the signals that are then automatically flashed over direct wires to the operators at traffic headquarters. This grouping of remote transmitters and receivers, more, possibly, than any other factor, has made

transoceanic radio a most economical communication system, resulting in lowered operating costs and still lower message rates. This economy, together with the direct communication service offered from one center to another, instead of from coast to coast, as with most cable systems, has brought transoceanic radio communication into wide and steadily growing favor.

The double translation process of telegraphy—translating the message into the dots and dashes of telegraphy for transmitting, and the retranslating of these dots and dashes back into characters and words—has been deemed an anachronism in this late day and age. As a consequence, the photoradiogram, or facsimile system of flashing the actual message itself through space, has been developed. This system permits of sending facsimile copies of photographs, drawings, maps, letters, finger-prints, checks, commercial documents, legal papers et cetera, over the established radio channels, without changes in the usual equipment except for the photoradio machines at both ends of the circuit. The photoradiogram service can be cut in on any radio circuit when there is a lull in telegraphic traffic, and cut out for the resumption of the dot-dash flow. In fact, the photoradiogram system itself employs dots and dashes in interpreting the facsimile image into signals.

Although still in its infancy, the photoradiogram is already gaining extensive use. Photographs are being flashed across the oceans and continents so that word pictures of news events are accompanied by the graphic story as well. Thus Colonel Lindbergh's spectacular flight across the Atlantic was not only reported in the next morning's newspapers through the agency of radio bulletins, but radio contributed photoradiograms showing the "Spirit of Saint Louis" resting at Le Bourget, 3,200 miles away. Americans, therefore, had the radio news in words and pictures in their newspapers at the breakfast table the next day! The photoradiogram has important commercial value. Valuable documents may now be flashed in facsimile form, with signatures, for prompt and authorized action. In order to test this possibility, the writer recently flashed his

check from London to New York over the transoceanic photoradiogram system, and the check was duly honored when presented for payment at the bank.

The real function of the photoradiogram of the future, however, is in multiplying the number of words that can be flashed through space in a given time. The economics of any communication system are simple enough: the investment and operating costs as against the number of words handled, tell the story. The greater number of words, without increasing the costs, the more economical the system becomes. Hence if the photoradiogram can be developed to that stage when an entire page of type matter or typewriting can be flashed as a unit within a short space of time, it will prove a notable and important economic advance even over the present automatic transmission and reception of radiograms.

Once more we return to those early days of radio communication, this time to pick up the thread of still another branch of the art—mass communication, or what is better known as broadcasting. The technical foundation of broadcasting is the radio telephone. Broadcasting is simply an ingenious application of the radio telephone. Hence our story goes back to that time when the voice was essayed in place of the cryptic dot and dash.

As early as 1907, European and American experimenters worked on the problem of wireless telephony, as it was then called. The results, however, were discouraging. First of all a suitable generator of radio waves was sadly lacking. Secondly, a suitable means of controlling the radio energy, so that it might carry a faithful impress of the sounds to be transmitted, was not in sight. Wireless telephony was admittedly an interesting but hardly promising laboratory experiment.

Skipping a decade or so of slow but steady progress, with many inventors taking part, we come once more to the World War—that inspiration for many technical achievements—the sole salvage, in truth, of a terrible calamity. Artillery observation planes were in need of a suitable "voice" to report what their "eyes" saw from the heights. The dot-dash language of

the telegraph code was too slow; and, what was more to the point, the best observation officers were not always adepts at dot-dash communication. The necessity of developing suitable radio telephone equipment was of paramount importance to our artillery. As usual, necessity was the mother of invention. The practical radio telephone followed.

Following the war, the Westinghouse Company engaged in a series of radio telephone experiments at East Pittsburgh. These were merely in the nature of testing radio telephone transmitters and particularly the microphones. The handful of radio amateurs then "on the air" were invited to participate in the tests and to report the results. Thus was inaugurated mass communication, soon to take fire in the public mind as broadcasting.

The officials of the Westinghouse Company had the vision to appreciate the possibilities of this mass communication system. By placing attractive musical programs and news bulletins on the air, so they reasoned, there would be created a demand for radio receiving equipment for use by the public at large.

Late in 1920, the first radio telephone station, KDKA, for regular mass communication service, was erected at East Pittsburgh. On November 2nd, the Westinghouse organization began sending out the first regular program service, starting with the announcement of the Presidential election returns. Just a handful of radio listeners participated, but history was in the making.

Never has any new institution taken such rapid and firm hold as broadcasting. From the pioneer KDKA in East Pittsburgh, the idea spread to New York, when WJZ was installed at Newark to serve the metropolitan area, then to Chicago, Philadelphia, and elsewhere, until within a short time dozens of broadcasting stations were in operation.

In a half dozen years, broadcasting has developed from an experiment to a nation-wide and even world-wide institution. To-day there are almost seven hundred broadcasting stations in the United States alone, pouring forth daily a variety of entertainment into the home of a quality and diversity which

no monarch of the past could ever hope to command in a life-time.

Not alone in numbers, but in technique and artistry as well has broadcasting progressed rapidly. At first the power employed for transmitting was based solely on favorable conditions, with the result that the adverse weather of mid-summer found reception very poor. However, with a growing appreciation of the importance of basing power on adverse, rather than favorable, conditions, broadcasting stations have steadily increased transmitting power until signals of ample strength are now available for reliable summertime service. Even the rural sections, far removed from the broadcasting centers, now enjoy, for the most part, reliable broadcasting service.

The artistry of broadcasting has kept pace with technical progress. Improved methods of pick-up and amplification at the transmitting end, together with marked improvements in home receivers and loud speakers, have been met with better and still better programs. Amateur talent has become the exception rather than the rule. Professional talent of the highest type is available regularly through the leading stations.

For the purpose of centralizing broadcasting efforts and ensuring the permanency of this gigantic institution the National Broadcasting Company was formed, late in 1926, by the Radio Corporation of America. This organization acquired WEAF in New York City, as the key station and nucleus for a nation-wide system of scattered broadcasting stations. Later, the management of station WJZ was also turned over to the new company. The Red and the Blue Networks were then established, with those two as the key stations, and still later the Pacific Coast, or Orange Network, was added, giving virtually a nation-wide coverage when desired through the many scattered stations. As an example of the national scope of these three networks, during the recent Dempsey-Tunney fight at Soldiers' Field, Chicago, some seventy-two stations were joined together throughout the United States and Canada, with at least two short-wave radio transmitters flinging the broadcasting to such distant points as Great Britain, France, Germany, South America, and Australia.

With the formation of the National Broadcasting Company and its vast array of stations, the American public has been assured of the stability of broadcasting. The economics of broadcasting have been effectively solved through the sponsored program, whereby it becomes possible to obtain a new variety of good will and public respect via the microphone, in exchange for the support of a worthy program. Network operation above all has made this new-day publicity most effective, by gathering together a widespread audience of millions to justify the enormous yearly expenditures for professional talent.

Of importance surpassing even the formation of the National Broadcasting Company, as far as the immediate status of the broadcasting art is concerned, has been the work of the Federal Radio Commission, established by Congress in March, 1927. At a time when radio legislature failed and the unlimited use of any and all wave lengths and transmitting powers brought about a condition of chaos which threatened to undermine the broadcasting structure, this Commission did most effective work during its first year of existence. The previously unsatisfactory state of affairs has been rapidly cleared up, without working undue hardships on legitimate broadcasters who have invested large sums of money to gain a place "on the air."

Nationally, broadcasting is a well-established and indispensable institution, providing entertainment and enlightenment to the American public. Yet once more American enterprise seeks greater fields. With broadcasting efforts overflowing our national boundaries and reaching out to other countries, an exchange of radio programs has been sought. While the ambition may be a bit in advance of the achievement, still the idea is by no means fantastic. Daily, several of our leading broadcasting stations broadcast their programs on short waves as well as on the standard broadcast wave lengths. The short wave programs are picked up in distant lands, often halfway round the world, due to the marvelous carrying powers of short waves. American programs are often available in Great Britain, Europe in general, South Africa, India, Australia and

Latin America, by means of short wave transmission. Meanwhile, there is promise that other countries by similar means may make their programs available to American listeners through the interception of short wave signals at favorable points, followed by their retransmission on the usual broadcast wave lengths. Already American listeners have enjoyed the thrill of London dance music and the strokes of "Big Ben," but the undertaking was purely in the nature of an ambitious experiment.

In the wake of broadcasting came radio receiving equipment, and with increasing progress in radio receiving equipment came better broadcasting, and so on in a never-ending cycle of progress. From what had hitherto been the mere hobby of American youth, there sprang up a great industry. From an annual trade of two millions of dollars prior to broadcasting, the volume rose to the stupendous figure of six hundred million dollars a year, in half a dozen years, with the limit not yet in sight. From perhaps less than one hundred thousand homes equipped with radio receivers, for the purpose of listening to dot-dash signals of radio stations, we have to-day at least seven million radio sets in use in as many homes scattered from the Atlantic to the Pacific.

In six short, thrilling years, the radio industry has evolved into one of our leading industries due in largest measure to American initiative, organizing ability, and public confidence and support.

The past of radio has been full of surprises, and kaleidoscopic changes. They were part and parcel of the rapid evolution. To-day we have evolved from out of the flux of yesterday. We stand on safe and sane ground. Those who have contributed as generously as they have received from the radio art—those who have come into radio to stay—have remained and prospered. On the other hand, the opportunists and others who rushed in for the enormous profits that might be reaped, without thought or desire of contributing their share to the welfare of radio, have been eliminated.

The future of American radio, therefore, can mean no less than the continuation of the present achievement on a vastly amplified scale.

XXX

THE INDUSTRIAL MUSEUM

By F. C. Brown

Director, Museums of the Peaceful Arts

"Man is a Tool-using Animal. Weak in himself, and of small stature, he stands on a basis, at most for the flattest-soled, of some half-square foot, insecurely enough; has to straddle out his legs, lest the very wind supplant him. Feeblest of bipeds! Three quintals are a crushing load for him; the steer of the meadow tosses him aloft, like a waste rag. Nevertheless he can use Tools, can devise Tools: with these the granite mountain melts into light dust before him; he kneads glowing iron as if it were soft paste; seas are his smooth highway, winds and fire his unwearying steeds. Nowhere do you find him without Tools; without Tools he is nothing, with Tools he is all."

CARLYLE: "Sartor Resartus"
Book I, Chap. V.

THE last hundred years is distinctive, in comparison with any previous hundred years, in the progress that man has made in the mastery and utilization of the physical forces of the universe. Simply in the matter of power the average man has directly and indirectly the equivalent of fifty slaves. The engines and motors in the factory, the gas engines in the automobiles, the steam power in railway trains and ships, the conveniences in the household and numerous other places, all serve man directly and indirectly.

Of more consequence than the added man power is the advance in efficiency. The power involved in telephone communication is inconsequential. In a few minutes a station in New York may be connected with a station in San Francisco and once connected the conversation can be carried on as effectively and expeditiously as could be done if the two persons

were conversing blindfolded in the same room. With any number of slaves selected and trained for quick reaction time and fleetness of foot, it would take nearly a month to get the shortest message and answer across the continent. However, if a hundred thousand slaves were placed a hundred and fifty feet apart and if a message were relayed by word of mouth, it would take about twenty-four hours to get a reply. Similarly a radio station of power equivalent to ten thousand slaves may simultaneously transmit a speech or a concert to ten million ears. No slave power in the world could even approach such a result without the mechanisms of science and industry.

We have, in America, museums that depict the wonders accomplished by man in art, architecture and the like, and museums and parks that show the wonders of animate life, and now the time is ripe for a museum that will depict, in a living way, the wonders of science and mechanisms that have been the basis of this century of greatest development. It is a wonder century, challenging the imagination like the starry heavens challenged the shepherds of old, and wonders happen so frequently that to-day a man, in three score and ten years, has a greater experience than ten generations of men would have experienced in centuries gone by.

From time immemorial society has believed in the value of records. Our libraries have countless histories based upon the records left by our ancestors. In the main, these records stand as word pictures. These concern mostly social, political and philosophic and religious development, wars, memorials and the like. After all, the mechanisms of past centuries were negligible in comparison with our present era.

There is, therefore, the great opportunity and even the necessity to leave records of the mechanistic side of civilization. In fact, our philosophers and historians tell us that our inventions and discoveries are responsible for the present-day trend of our social, moral and religious development. We already know some of the results on society of the printing press, the Whitney cotton gin and the McCormick harvester.

It has been said that the study of History and Philosophy has a very broadening influence on the student. That so

many men have lived through, in a way, the experiences of their ancestors is responsible for the stability of growth of human institutions. This is very ably supported in an editorial [1] in *Nature,* in part as follows: "As a medium of culture, the history of scientific discovery opens up to the imagination vistas of man's endeavor which place it in the front rank of humanistic studies. Through a general familiarity with the methods of scientific observation and experiment in the various branches of research may be developed a critical attitude in judgment, a power of observation and a capacity for orderly arrangement; while a knowledge of the questions with which science as a whole is concerned in the past, present and the future fosters the broad outlook which, in combination with these qualities, is essential in successful dealing with the problems of life. We doubt, however, whether much of the science teaching in schools, either primary or secondary, could be regarded as science for citizenship instead of science for specialists, and we should welcome a movement which would broaden its scope and change its character."

As far back as records go, this history was depicted in the institutions of religion, government, transportation, architecture and art. But all of a sudden, like the outburst of the flower, we are in a civilization in which science and its application are seemingly the warp and the woof of the fabric of which we are all a part.

In our colossal industrial progress, it is highly desirable that we advance with sanity and with minimum waste. Just recently I heard of one manufacturer who changed his entire equipment four times in four years. This may have been necessary because of new scientific information, but it more likely represented in part an unnecessary waste arising from lack of information already available.

Just as a wide dissemination of the facts and the meaning of History will tend toward a reduction in the waste arising from political revolution, so will a wide and clear presentation of the development of the Industrial Arts and the underlying sciences tend to stabilize our industrial progress and to prevent

[1] Quoted in *Science,* October 14, 1927, p. 355.

unnecessary waste. Because of the complexity of the industrial mechanisms that surround us in our daily life, very few can understand them by word and diagram pictures. Moreover, the limits on human time and energy are such as to require the most attractive and clear presentation in order that the public will even attempt to follow industrial developments. The museum will essentially, by the selection of simplified and fundamental visitor-operated models, present to the visitor an enticing and understandable picture of industrial growth in every line.

Mr. Pendred [2] has said that "man's power of invention is very limited; his power of thinking will not permit him to take a long step at any time." A stimulating historical mechanical museum will do much to promote sane invention and particularly to carry over the fruits of invention in one field to related fields. One successful and wealthy industrialist has said that one secret of his success has been in his persistent search of related industries for new ideas to apply in his own manufacturing.

To further quote Mr. Pendred: "There is no better method of instructing youths in the higher branches of technology than by leading them step by step through successive developments. The young student of steam engineering, to take an example, is in exactly the same primitive intellectual state with regard to steam as was Papin or Savery. He is, therefore, in a condition to understand those two pioneers and, once having mastered the principle of the raising of water by the condensation of steam, he is in a position to take the next step—the interposition of the piston by Newcomen, and is easily led forward through Sweaton's improvements, and the employment of the 'pickle pot' condenser until a state of mind similar to that of Watt's is induced. He is, therefore, able readily to appreciate the separate condenser and can be brought by easy stages to the comprehension of Watt's difficulties about the properties of steam. To follow the simple researches of that

[2] Presidential address on "The Value of Technological History," by Loughnan St. L. Pendred, M.I.Mech.E., Transactions, Newcomen Society, Vol. IV, p. 1, 1923-24.

great man offers no difficulties to him, but fills him with a gentle excitement as each step is discovered afresh. From Watt to Trevithick is a short jump, and the student now finds himself in possession of the fundamental principles of the low pressure and of the high pressure engines. . . .

"By successive steps the student at length becomes acquainted, and thoroughly acquainted, with the essentials of steam engineering with no more effort than reading an entrancing history. What may be done with the steam engine may be done with other developments of inventions."

The Industrial Museum will have living depictions of the advances. That is, the student will see reproduced models work, either on full-sized or reduced scale, or simplified, as may seem best.

We can imagine what the influence of the radio and the airplane will be on our business and social institutions.

In such a museum, the expert in any field of endeavor will see the progress that has been made. He will note the steps that have been made successfully. And the newest instrument or device will give him the last achievement. It is much easier and clearer to follow the development of machines from working models than it is from words and pictures alone. For example, one highly developed Ph.D. said recently that had he seen the Munich Museum some years back, he would not have wasted some thousand dollars on an invention, which, by the way, he could ill afford.

But of even greater importance, the expert in one field of endeavor can see at a glance the means by which the experts have progressed in related fields. One millionaire recently told the author that he believed this would be the greatest usefulness of the museum. He is a chemist, who started with a good training, but without capital. Nearly all of his success he attributed to the application of ideas that he sought and found in other than his working field. It is known that the talking machine has been reborn and elevated by the adoption of information gained from the communication industry. Likewise it is known that the vitaphone is responsible to the telephone industry.

Perhaps the philosopher alone can evaluate the worth of such a museum of machines to the layman. Who knows what it is worth for a man to be attracted to get a living picture of how his fellowmen earn their living in the highly specialized industries? Is it not as broadening as travel?

The method of presentation is, to a considerable degree, determined by the fact that the appeal is to be made to the layman rather than to the highly specialized expert in his own field. With the development of machinery, our entire population is becoming highly specialized and so it is that all men are laymen in most things.

In general, therefore, the museum will be directed to the boy and girl of sixteen, and in so doing it will reach the boys from eight to eighty.

Fundamentally the industrial museum differs from the usual technical school in that it will offer no degrees, diplomas, or even credits, to hold its students. There will probably be a million students a year visiting the museum in classes. Except for these the museum must lure its visitors. It should compete with the theater, the library and the zoo, both in allurement and in sustained interest.

In his study of the industrial and scientific museums abroad, Professor Joseph W. Roe evaluated types of exhibits in the following order as regards interest to the visitor. First, the exhibit where the visitor can, by pushing a button, turning a crank, or other unmistakable operations, illustrate some fundamental facts. Somehow cause and effect in the mechanical world mean more to the human being if, by his will, he can institute the cause for the effect which he sees. Such exhibits, carefully chosen, will excite the imagination, give information and develop methodical thinking. There are great possibilities for increasing the desire for knowledge about material things. Having tuned in on the interest of the student by such exhibits, every other variety of exhibit may be shown to give more complete information.

The second order of exhibits are those where an assistant or lecturer performs the operation. This type is advisable in some

instances, particularly where a large number of operations are necessary, such as the work done by the craftsman.

The museum as a whole, will be a temple dedicated to craftsmanship. In every mechanistic control of the forces of nature, there is always found somewhere the work of the craftsman. Before machines turned out lamp bulbs automatically by the millions, there were the glass blowers for generations and generations. The skill of the best of their kind entitled them to the feelings and emotions of the prima donna. The craftsman is the father of the automatic mass production machine. But in the birth of the mass production machine he has not died or been forgotten any more than the horse has died with the birth of the automobile. The craftsman creates, whereas the machine only repeats its operations. He is vital to society not only in the sense that the father of the child is vital, but because he must produce the new and lead the way, and upon him and his kind falls the obligation to make the machines that make the imitations of the craftsman.

For the same basic reasons that men love to see men run or fight, men also love to see the craftsman create. What man, woman or child would not stop to watch an expert village blacksmith? Would not the layman be interested in seeing the glass polisher or the diamond cutter at work? It would be worth while to the shoe manufacturer to let the average woman see how much skill and how many operations are involved when a shoemaker produces a fine pair of hand-made shoes. Might not we profitably show the hand-weaving of linen, of rugs?

A thermometer maker in a space of twelve feet square can make clinical, or fever, thermometers, which are so common to every family. A high grade lithographer would always command attention at his work. And so it has been suggested that some twenty or thirty high grade craftsmen be found in various lines and that in suitable departments of the museum they carry on their daily work before the eyes of millions. It would dignify and glorify high grade workmanship and would make for the brotherhood of man.

The third type of exhibit is a machine or a process in con-

tinuous operation, such as frequently used in store windows for advertising. In many instances this type may be more useful in clarifying an operation where the interest has already been aroused.

The next in importance for creating interest is the facsimile model. Such models, however, are important to complete the story that may have been started by other types.

The lowest order of exhibits for creating interest is either dead models in glass cases or charts and pictures. Moving pictures may be most useful in clarifying the development at certain stages.

The industrial museum may be called an institution of this century. In Europe there are many already among which the Science Museum at South Kensington, the Deutsches Museum at Munich, the Technisches Museum at Vienna and the Conservatoire des Arts et Metiers at Paris are well known. Thousands of Americans visit these institutions annually. These institutions are well described in a book entitled "The Industrial Museum" by Charles R. Richards. (Published by Macmillan Company, 1925.) Mr. Richards apparently thinks there is more reason for such museums in America than elsewhere in the world. He says, "The processes of production that underlie the civilization of to-day are hidden behind factory walls where only the specialized factory worker enters. Little is known about these operations by the growing boy and girl. To attempt to present these things through books is unsatisfactory and tame. The processes must be revealed to the eye and set forth in the simplest and clearest possible fashion if the foundations of our present-day life are not only to be understood, but to become an element in the culture of to-day. The industrial museum in its highest development endeavors to accomplish this purpose by displays of materials that clearly and succinctly illustrate industrial processes in ways that may be readily understood by both young and old." Dr. John H. Finley, after visiting the demonstration exhibits of the Museums of the Peaceful Arts, said editorially:[3] "It is not

[3] *New York Times,* May 26, 1927.

only a means of popular culture and scientific education, but as Professor Miller has said, 'is a veritable playground for the boy from eight to eighty.'"

It seems that all at once America is waking up to the need of the Industrial Museum. The Franklin Institute has available nearly two million dollars toward the construction of a museum building, and has the expectation of a most desirable building site.

Chicago is to have a great industrial museum, to be known as the Rosenwald Industrial Museum. In addition to the three-million-dollar gift of Julius Rosenwald, the city has authorized the South Park Commissioners to issue $5,000,000 bonds and apply the proceeds toward the building project. The museum will be constructed upon the site of the Fine Arts Building (of the World's Columbian Exposition, 1893) in Jackson Park, Chicago, and the new building will be an exact reproduction of the former structure, which is recognized as a superior example of Greek architecture.

The Smithsonian Institution proposes to build up in the National Museum an exhibit showing the history, development and present problems of steam power plant engineering. Three thousand square feet of floor space have been made available for this purpose. This is indicative of the Smithsonian Institution's interest in the movement now under way for the establishment of an industrial museum. Within a year, therefore, it is anticipated that a fairly complete department will be available to the public and to museum authorities who may be interested in such a project.

The Museums of the Peaceful Arts in New York City was incorporated by a group of public-spirited citizens in 1912, and just recently, as a result of income from the estate of the late Henry R. Towne, the Board of Trustees is laying plans to provide an institution worthy of the world metropolis. A museum of sample exhibits has been instituted at 24 West 40th Street, where selected groups are invited for entertainment and the exchange of information. As a result, much interest has been created and two major industries have indicated in-

formally their expectation to start an industrial museum and to have these housed in the New York institution. The city will probably soon show its interest in rendering this service to its own people as well as to the visiting millions of people from other states who have done so much to make New York what it is. This interest is expected to be manifested in the provision of a suitable site.

A proposed layout for the Museums of the Peaceful Arts is, in addition to offices, conference rooms, library, auditorium, lecture rooms, shops and printing, to be set up in three divisions as follows:

	Area in Sq. Ft.
DIVISION I	
Fundamental Sciences	18,000
DIVISION II	
Basic Industries and Power	
Agriculture and Forestry	25,000
Mining and Metallurgy	25,000
Generation of Mechanical Power	30,000
Generation of Electrical Power	30,000
Transportation and Mechanisms for Merchandise Distribution	40,000
Communication	12,000
DIVISION III	
Derived Industries	
Metal and Woodworking Industries	40,000
Chemical Industries	30,000
Food Products and Vegetable Industries	25,000
Clothing, Textile, etc., Industries	40,000
Paper and Pulp Industries	8,000
Stone and Earth Industries	10,000
Building Construction	12,000
Household and Hotel Engineering	12,000
Safety and Industrial Hygiene	10,000
Graphic Arts and Devices for Banking and Business	25,000
TOTAL EXHIBITION AREA	392,000

	Area in Sq. Ft.
Administrative Offices and Conference Rooms....	10,000
Mechanical Shop, Printery, Properties, etc.	10,000
Storage	40,000
Library	40,000
Auditorium and Lecture Room......................	20,000
TOTAL FLOOR SPACE.........................	512,000

As examples of exhibits the first one in the power section will be Hero's engine. The visitor will press a lever and the engine will start whirling very much like the first engine. It will be clear that the rotation is caused by the reaction of gas or steam issuing from small jets.

In the electrical section there will be a model of Faraday's disk, which the visitor can turn by a crank and observe on a small ammeter that the faster he turns the more current is generated. If he turns fast enough he will see a miniature lamp begin to glow and then he will realize for himself that this is the great-grandfather of the modern dynamo which furnishes electricity to light our houses and our streets. And near by there will be Franklin's kite, apparently in a cloud. The visitor takes hold of the silk cord with one hand and brings his knuckle near the key attached to the kite string and gets a shock as Franklin did. This and other suitable reminders of Franklin's experiments give the spirit of wonder that has remained with the lay public as well as with the students of electrical engineering up to the present time.

In transportation there will be a model of "Puffing Billy," which runs with the wheels slightly raised above the tracks and with the piston head sectioned, so that the boy may see why it worked. And so every important step in steam locomotives, automobiles and airplanes will be made clear.

In communication there will be all the steps from Bell's first telephone to the present time, among which will be various working models to illustrate why we can talk over wires. And the radio will be replete with wonderment throughout, starting with visitor-controlled standing waves on two parallel wires

and ending with a simple model explanation of the newest amplification tube.

And so there will be acres and acres filled with live and alluring exhibitions.

For the section on Pulp and Paper, Dr. Hugh P. Baker, Executive Secretary of the American Paper and Pulp Association, has suggested the following outline in this particular major industry. His statement of why the pulp and paper industry lends itself to graphic presentation in the Museums of the Peaceful Arts it is hoped may be a guide for others to follow.

"There is no medium which lends itself so well to the communication of a thought or a message from one individual to another as paper. The slowly developing use of paper through the centuries is filled with romance. In the history of its gradual development is the story of a man's efforts to express and record himself in picture and word. This story of the effort to produce more and more and better paper upon which man may express and record himself is a fascinating story which lends itself in an unusual way to museum use.

"One has but to consider the part which paper plays in the daily lives of our people and in business and industry to appreciate the fact that paper is a basic commodity and that its manufacture is a fundamental industry. By far the larger part of the paper manufactured in this country to-day is based upon a raw material coming from a replaceable natural resource—the forest. In taking wood from the forest and turning it into paper there is involved the application of a number of different sciences: biology, chemistry, engineering and forestry. This means that the industry is one of evolution and action. Paper indeed lends itself to a museum in which craftsmanship and animated industry are to be the keynotes.

"Man's first step upward toward civilization was evidenced by his effort to make a record of his environment and his accomplishments and particularly his heroic deeds, so we have pictured rocks and the pictured walls of caves. The next step was logically the development of the simple and primitive alphabet so we find the ancient Egyptian cutting cuneiform

figures on soft bricks which were afterwards baked so that they might be permanent. Skins of animals and barks of trees were used as mediums upon which to tell man's story. Doubtless at the time the Egyptian was cutting the cuneiform figures on bricks the primitive peoples of Northern Europe were crudely engraving their life stories on ruder stones and these still stand as a record of this effort. The Egyptian, finding that bricks as libraries were bulky and easily broken, gradually developed papyrus from which the word paper comes. This, however, was not true paper but rather built-up sheets or strips of the papyrus reed pasted together so as to form a sheet upon which figures and words might be imprinted.

"So far as we can determine, the first paper, as we know it to-day, was made in China. The fibers of certain plants were separated by maceration in water into very fine particles and then were laid together into a sheet by the further use of water. The first Chinese paper was probably made from the thoroughly disintegrated inner bark of the mulberry tree. The Moors brought the process of paper making into Spain and from there it was taken northward into France, Germany and England.

"When paper was first made in Southern Europe, the secret of its manufacture was very carefully guarded and craftsmen were trained and watched to see that they did not give the secret to others. In the early making of paper in Europe the fibers of cotton and linen rags were separated by beating in water and this was of course done by the hand. Gradually through the years there were developed crude machines run by water power in which the fibers were beaten.

"While the separated fibers were held in suspension in the water by agitation a frame upon which there was stretched a fine mesh wire was dipped into the vat and as it was lifted out the water drained away leaving a sheet of fiber. This was carefully lifted out of the frame on a piece of felt and dried and the result was the first hand-made paper.

"From the museum standpoint the primitive process of beating the fiber of cotton or flax and the making of the handmade sheet of paper offers opportunity for an animated exhibit

which would be exceedingly interesting and instructive. It should be possible to secure some of the early hand frames used in this country and without doubt it would be possible to secure one of the older men from a fine paper mill to make paper by hand in the museum. In connection with this making of hand-made paper it would be easy to secure samples of early hand-made paper in the form of old documents and books.

"History has it that the first thought of using wood for paper developed in the mind of a Bavarian monk who, watching the wasp building its nest and afterwards inspecting the nest, determined the fact that wood could be made into a sheet of paper. Thereupon this Monk ground a piece of wood to fiber by pressing it against a grindstone which was kept constantly wet. From this pulp he made a crude sheet of paper. However, it took many years for the idea to be put into practical effect and not until well into the last century were practical processes for the use of wood as a raw material for paper developed on a satisfactory basis.

"The procedure of getting the wood out of the forest, peeling off the bark, and removing knots and rotten portions and then reducing the cleaned wood to pulp through mechanical action or by the use of acids or alkaline materials is a story which could well be known graphically in a museum. In fact, it should not be difficult to have a small demonstration digester in which the chips could be turned into pulp before the eyes of the observer.

"By pictures either still or moving and by exhibits, it should be possible in the museum to tell the fascinating story of the turning of the forest into the paper in its many forms.

"The cutting or logging of the forest and the driving of the timber down the river to the mill is a story filled with romance, but it might be difficult to get animation into this story. However, models and figures could be used in such a way as to be exceedingly instructive. What a story could be told through models of a forest, a miniature logging camp, a log drive, with the river driver, the bateau and the wanigan and sometimes the log jam. Certainly this story of logging and lumbering and the turning of the wood into pulp is one that can be told to advantage in a museum.

"There is a great story in the forest as a dynamic factor in nature. America has been extravagant indeed in the use of her natural resources and there has been almost criminal waste in the way we have allowed forest land to burn over after the timber has been cut. Yet the forest *is* dynamic and if the land, after cutting, is protected from fire, small trees come back and soon a new forest has taken the place of the old one.

"Gradually as man uses the forest to the point of exhaustion, wood becomes of greater value and he makes an effort to replace it. Therefore he introduces practical methods of protection of the forest from fire and organizes to fight fire after it occurs. He develops nurseries in which small trees are grown and then plants these out and protects them so that they may develop into forests of commercial value. No other wood-using industry to-day is doing so much to conserve the forest and to produce wood for industrial use as the pulp and paper industry. Forestry is being practiced by the pulp and paper industry to-day—it is growing pulp wood for the manufacture of paper.

"From a museum standpoint it might be said that the forest makes a dead exhibit. However, through models of mature forests, of cut-over lands, of burned-over areas, of nurseries, of replanted lands and with pictures, both still and moving, a fascinating story could be told of man's use of the forest and his effort to bring it back on a satisfactory basis.

"Man's ingenuity and necessity as applied to early hand processes for the manufacture of paper led gradually to the development of machinery. From the wire hand frame upon which paper was formed there was developed the moving wire over a larger frame that would rapidly carry the fibers suspended in water as they came onto the moving wire to the formation of a continuous sheet of paper. The moving wire on a continuous frame was introduced by a Frenchman by the name of Fourdrinier and although he did not develop the wire it has taken his name so that to-day the modern paper machine is known as the Fourdrinier machine. From a moving wire only a few feet in width running at a speed of less than one hundred feet there has been developed through the years a

great paper machine with a wire more than twenty feet wide running at a speed of one thousand feet per minute. In the development of the paper machine there has naturally followed many improvements not only in the wire itself but in the equipment which sucks the water from the sheet of paper as it passes over the wire, etc., etc.

"The making of paper on a Fourdrinier machine lends itself admirably to museum use. It should be possible to install a small paper machine in the museum which could be run continuously and that on different grades of paper of varying colors and weights. In fact, it should be possible on this small museum machine to make paper for museum use.

"So far but little mention has been made of the use of cotton rags in the manufacture of pulp for the production of the higher grades of paper. There is not the same romantic story in the collection and sorting of rags to be shipped to the pulp mill as there is in the production of pulpwood from the forest. However, in connection with the running of the paper machine in the museum, it would be possible to use pulp both from rags and from wood. It would probably be impossible to actually produce in the museum the pulp to be used on the demonstration machine though, as suggested, a small demonstration digester might be operated so that a certain amount of pulp could be made in the museum both from rags and from chipped wood.

"Many different chemicals and dye-stuffs enter into the manufacture of paper to-day. How these chemicals and dye-stuffs are used in the bleaching, the filling and the sizing of paper could be shown easily in an exhibit. To-day the paper industry is a greater consumer of resin than any of the other industries in this country. It uses great quantities of English China clay, of casein, of sulphur, of alum, etc., and it would be possible to illustrate graphically how these various commodities enter into the manufacture of the modern piece of paper. So too with the use of dye-stuffs in the coloring of paper. Many different dyes are used and these could be used in the manufacture of paper in the museum as it is used in the paper mill.

"Instruments of accuracy have been developed for the purpose of determining the character and quality of different types of paper. These instruments are of such size that they would lend themselves in a satisfactory way to actual use in a museum exhibit; in fact most of them are of such a character that the observer could operate the instrument himself. For instance, the Mullen tester by which the strength of paper is determined, the instrument for determining folding strength, for the testing of absorption, for the determination of opacity, etc.

"Of all of the parts of an exhibit telling the story of the manufacture of pulp and paper in the museum, the section given up to instruments of accuracy to determine character and quality of paper would lend itself most satisfactorily to actual operation by the observer.

"Because of the wide ramification of use of paper to-day in every field of human activity and in many of our industries, it would be possible to show some of the many papers produced and used in this country as a still exhibit which should be of very great interest. From the highest grades of paper made of cotton and linen and used for paper money, to the lowest forms of paperboard used for shipment of commodities by freight and express, there is a wide limit in which there are literally thousands of different kinds and grades of paper. Nowhere in this country to-day is there a complete and satisfactory exhibit of paper; therefore, such an exhibit as that suggested in connection with a demonstration pulp and paper mill would give the most complete picture of the pulp and paper industry that has yet been developed.

"From the wooded slopes of the hills of New England and New York, from the great forests of the Pacific Northwest, and from the cotton fields of the South, materials are being taken and changed in a marvelous way for the production of paper in all of its diversified forms. In few industries is there so much of romance, so much of technical and scientific interest as there is in the pulp and paper industry. This industry should make sure that its story is fully told in the Museums of Peaceful Arts."